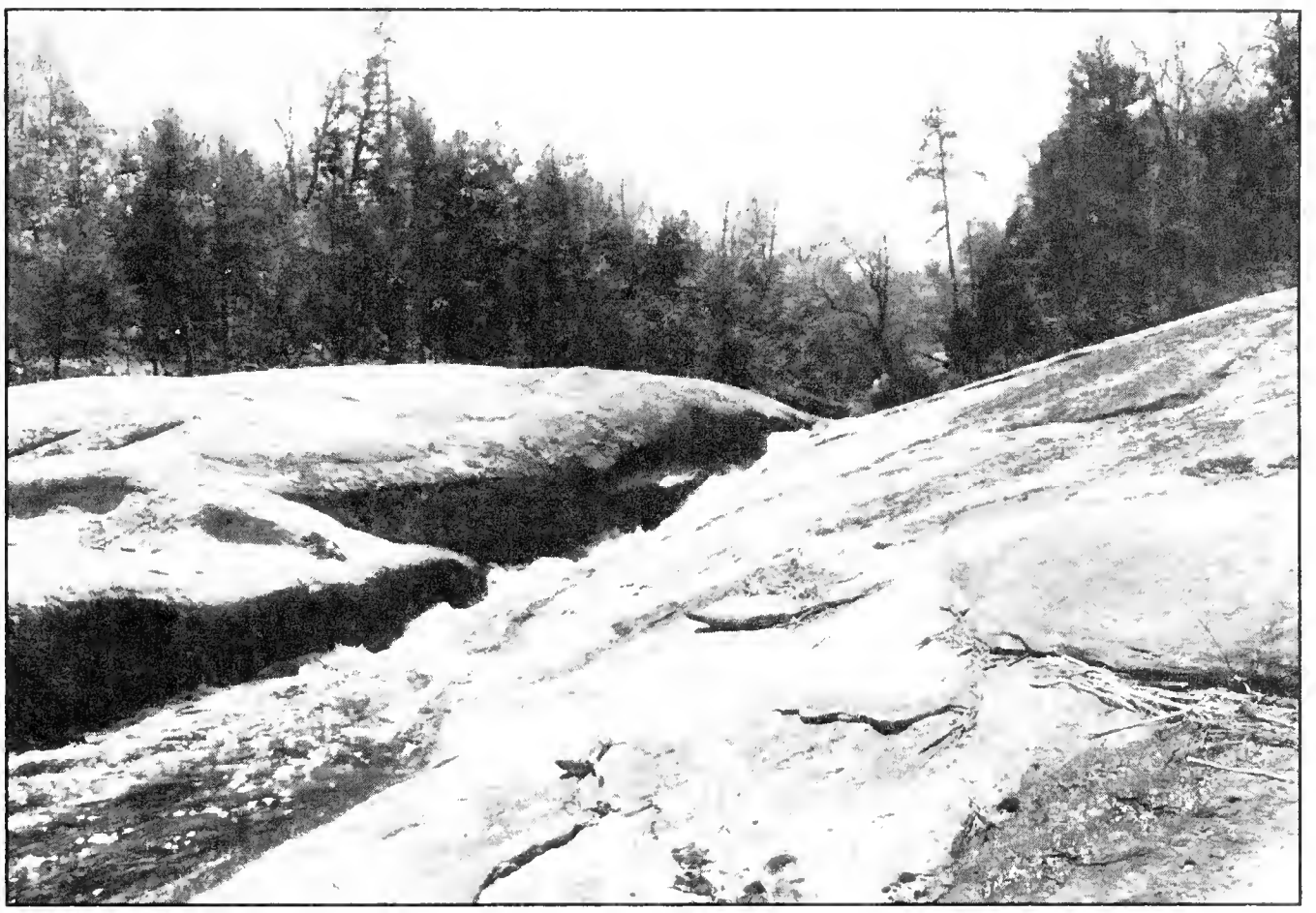
BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA



Cedar Creek Granite Flatrock

The interesting plant communities of this and other similar granitic outcrops in the Virginia Piedmont are discussed in the lead article of this issue.

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Table of Contents

Banisteria, Number 11, 1998

The Vascular Flora of Five Newly Discovered Granite Flatrocks in Virginia's Southern Piedmont

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INTRODUCTION

Granite flatrocks of the southeastern Piedmont and their associated plant communities have long been studied by botanists and ecologists. These outcrops of smooth, infrequently broken bedrock are located from Virginia through North Carolina, South Carolina, and Georgia into eastern Alabama. They range in size from a few square meters to many hectares (McVaugh, 1943). Quarterman et al. (1993) emphasized that these outcrops are often not true granite, but rather other granitic rocks such as granite gneiss or biotite granite. Schafale & Weakley (1990) described North Carolina granitic flatrocks as "outcrops of smooth exfoliating granite, adamellite, syenite, or related rocks, level or gently sloping, at about the same elevation as the surrounding land." Thus, these authors differentiated granitic flatrocks from granitic domes, which are characterized by steeper inclinations where vegetation mats are often less easily established.

Granite flatrocks are generally stressful environments for plant habitation. Factors which contribute to this include shallow soils, soil erosion, high levels of solar irradiance, extreme and rapidly fluctuating temperatures, and frequent xeric or droughty conditions (Quarterman et al., 1993). Vascular plant species are restricted to depressions, crevices, moss mats, and edge habitats with sufficient soil accumulation to support this vegetation. A variety of plant habitats are associated with granite flatrocks. These are briefly discussed later in this paper.

In his comprehensive monograph on granite flatrocks, McVaugh (1943) listed 17 vascular plant taxa believed at that time, to be endemic to granite flatrock plant communities. Although many of these endemics have subsequently been found on other types of bedrock outcrops, most are still primarily associated with granite flatrocks. The center of endemism for granite flatrocks is the upper Piedmont of Georgia, east of Atlanta. The number of endemic species decreases as one moves northeast or southwest from this center (Murdy, 1968).

In Virginia, most granite flatrocks are small, rarely reaching 0.5 ha in size. Most are found in the eastern portion of the Piedmont from the James River south. Three vascular plant species strongly affiliated with granite flatrocks further south are known from Virginia flatrocks: *Portulaca smallii* (Small's purslane), *Cyperus granitophilus* (granite-loving flatsedge), and *Diamorpha smallii* (Small's stonecrop). These species were first reported from Virginia by A.M. Harvill, Jr. (Harvill, 1976).

In this paper, five new flatrock sites located by the author in 1996 are described. Information is provided on bedrock geology, microhabitats, floristics, and site significance. Lists of plant species observed at each site are provided in Appendix 1, where the authors of all species are cited.

METHODS

Known granite flatrocks in Virginia were located on leaf-off color-infrared photographs taken in 1981-83 under the U.S. Geological Survey's National High Altitude Photography Program (NHAP). These aerial photographs were examined to determine distinguishing features (signatures) of known flatrocks. Flatrocks characteristically appear in these photographs as bright white, irregularly-shaped patches edged with scattered evergreen trees, particularly *Juniperus virginiana* (Eastern red-cedar). Small islands of woody vegetation are often observed. To search for new potential flatrocks, these features were sought on NHAP photographs of Brunswick, Lunenburg, and Mecklenburg Counties. In many instances, difficulties were encountered differentiating

rock outcrops from agricultural fields, other human environments, and floodplain wetlands. To help solve this problem, Virginia Department of Transportation black and white aerial photographs were examined. Many of these photographs were taken several years before or after the NHAP photographs. Thus, the signatures of potential flatrocks could often be compared over time. The signatures of undisturbed flatrocks maintain a generally constant appearance over a several-year interval, whereas those of human-influenced environments often show marked changes over time. Through this method, many sites were eliminated from further consideration.

At the completion of the aerial photograph review, county courthouse records were researched to determine the names and addresses of landowners of potential flatrocks. Landowners were contacted to verify the presence of flatrocks on their properties and to obtain access permission. Landowners were sometimes useful in providing leads to other flatrocks in their areas.

By this method, five new granite flatrock sites were located in the Spring of 1996 in Brunswick and Lunenburg counties. One of these sites, Dundas Granite Flatrocks, was visited five times during 1996: 16 April, 1 May, 16 May, 7 August, and 29 October. Two sites, Seepy Granite Flatrock and Cedar Creek Granite Flatrock, were visited three times during 1996: 1 May, 18 July, and 29 October. The fourth and fifth sites, Golf Course Granite Flatrock and Big Hounds Creek Granite Flatrock, were visited twice each during 1996: Golf Course on 2 May and 30 October and Big Hounds Creek on 6 June and 30 October. For each flatrock community, a list of all vascular species observed was taken. Where identifications could not be made with confidence in the field, collections were made

In order to record a species list for each flatrock community, it was necessary to determine the boundary between the flatrock community and adjacent communities. Schafale & Weakley (1990) placed this boundary where "shallow soil conditions and associated vegetation give way to the prevalent surrounding forest vegetation." This boundary definition was generally followed for this study, and transition habitats were included within the study areas. Where flatrocks were bisected by streams, associated riparian habitats were included to the extent to which they were surrounded by flatrock areas. The most difficult site at which to determine the community boundary was Golf Course, where a portion of the flatrock grades into the manicured lawn of a golf course green. A liberal boundary was used here because the granite flatrock near-endemic, *Portulaca smallii*, also extends onto the green.

RESULTS AND DISCUSSION

Description of Sites

Seepy Granite Flatrock (Fig. 1)

This linear-shaped flatrock is located in northeastern Lunenburg County approximately 25 m east of an intermittent, unnamed tributary of Cedar Creek. The flatrock is approximately 0.24 ha in size and slopes gently to the west towards the stream. The rock is surrounded by a young pine plantation, and other signs of disturbance are apparent. Mounded earth, apparently in conjunction with past timbering, is found along the edges of the rock. Trash has been dumped at the southern edge of the rock along a road. *Lonicera japonica* (Japanese honeysuckle) is well-established along the edges of the rock, and several other exotic species are present.

Dundas Granite Flatrocks (Fig. 2)

This site, located in northwestern Brunswick County, contains a series of flatrocks on slopes east of an unnamed tributary of the South Branch of Cedar Creek. The principal flatrock in the group is approximately 0.50 ha in size and rises rather steeply (at an inclination estimated at 20°) from the floodplain of the small stream. Aspect is west by northwest. Because this western portion of the flatrock rises more steeply from the floodplain than the contour of the adjacent slopes, this portion of the rock has a domed appearance. The eastern portion of the rock levels off to nearly flat.

Six smaller flatrocks are located nearby. The largest of these is approximately 0.10 ha in size. These rocks are located from 0.35 km north to about 40 m south of the principal rock. Two of these smaller rocks rise steeply from the floodplain of the tributary. The others have gentle westerly inclinations in conformity with the contours of the adjacent slopes.

For the most part, the Dundas flatrocks are surrounded by well-drained, open oak-hickory forests dominated by *Quercus prinus* (chestnut oak) and *Carya glabra* (pignut hickory). The southernmost rock in the complex abuts a *Pinus taeda* (loblolly pine) plantation. This rock is also crossed by an old logging road, and aggressive non-native plant species, such as *Belamcanda chinensis* (blackberry lily), *Centaurea biebersteinii* (spotted knapweed), and *Lonicera japonica*, are well-established here. The remaining flatrocks in the complex, however, are impressive for their lack of disturbance, intact surrounding forests, and relative scarcity of exotic species.

Cedar Creek Granite Flatrock (Fig. 3)

This site encompasses approximately 0.50 ha of

Fig. 1. Seepy Granite Flatrock. Note *Grimmia laevigata* mats in foreground. The disturbed flatrock edge at left is dominated by *Lonicera japonica*.

flatrock and other closely related bedrock habitats along Cedar Creek in northwestern Brunswick County. Rock outcrops here comprise a linear strip about 160 m long which is bisected by the creek. In one area, the creek flows through an impressive chute carved by water into the bedrock.

Bedrock outcrops at this site are associated with a series of stream terraces which flank the creek. Expanses

Fig. 2. The principal flatrock at Dundas Granite Flatrocks site. Note *Grimmia laevigata* mats in the foreground. In the middle ground, a large crevice contains soil deep enough to support *Pinus taeda*.

of smooth flatrock are broken by boulders and small ledges. Much of the area is subject to inundation during periods of high water.

A woodland with *Juniperus virginiana*, *Carya glabra*, and *Quercus alba* (white oak) is located on slopes above the main flatrock area on the northwestern side of the creek. The substrate here is a series of small scattered outcrops a few square meters each in size with intervening areas of thin soil. Herbs found in this area include *Cheilanthes lanosa* (hairy lipfern), *Clematis ochroleuca* (curly-heads), and a *Matelea* (anglepod) species (vegetative in 1996).

Cedar Creek Granite Flatrock is surrounded on both sides of the creek primarily by mixed forests on well-drained, moderately steep slopes above the outcrops. Some recent timber harvest was noted here. Other disturbances include a dirt road which crosses the flatrock at its southwestern end and a recently constructed house and large picnic shelter on slopes above the flatrock to the southeast. Non-native plant species are prevalent in the vicinity of the road, but are scarce elsewhere on the rock.

Big Hounds Creek Granite Flatrock (Fig. 4)

This flatrock is located northwest of Kenbridge in eastern Lunenburg County near the junction of two tributary streams of Big Hounds Creek. Approximately 0.30 ha in size, the flatrock slopes gently to the southwest towards the smaller of the end of the flatrock through a shallow, poorly defined channel.

Big Hounds Creek Granite Flatrock is separated from a pasture upslope by a narrow strip of woodland buffer. While a fence keeps livestock off of the flatrock, pasture weeds, such as *Festuca pratensis* (meadow fescue) and

Dactylis glomerata (orchard grass), have invaded. *Rosa multiflora* (multiflora rose) and *Ligustrum sinense* (Chinese privet) are also present. In addition, vehicle ruts were observed, but these were not recent.

Golf Course Granite Flatrock (Fig. 5)

This L-shaped granite flatrock, located in southern Brunswick County southeast of Gasburg, is approximately 0.12 ha in size. The flatrock is bisected by Cold Spring Branch, which divides the rock into two approximately equal sections and whose narrow channel is etched into the bedrock. This low gradient small stream flows to the southeast from the flatrock to join Lake Gaston in about 0.1 km.

This flatrock is surrounded, for the most part, by disturbed habitats. The northern end of the rock grades into the manicured lawn of a golf course green. A maintenance road for the golf course is located a short distance to the south, and much of the intervening land has been cleared. To the west, thickets provide some buffer from other cleared areas. Most of the intact natural habitat lies to the east and consists of bottomland forest along Cold Spring Branch.

Lawn weeds, such as *Poa annua* (annual bluegrass), *Eleusine indica* (India goosegrass), and *Aphanes microcarpa* (parsley-piert), are found at this site in areas where the flatrock grades into the golf course green. More characteristic flat rock exotics, such as *Lonicera japonica* and *Ligustrum sinense* are also present.

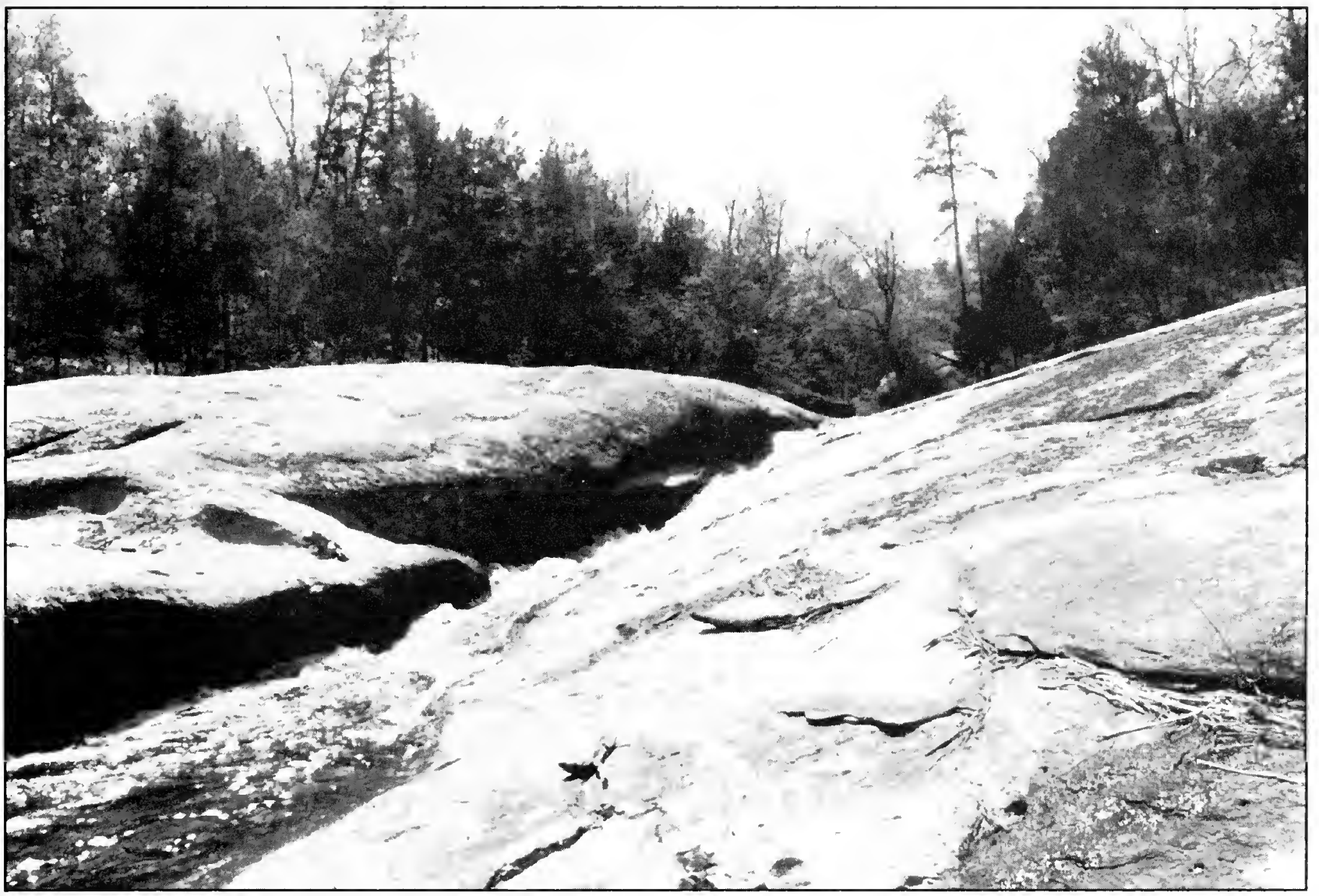

Fig. 3. Cedar Creek Granite Flatrock. The flatrock is bisected by the creek, which flows through a chute carved into the bedrock. Moss mats on the rock on the right side, middle ground, support *Talinum teretifolium* and *Minuartia glabra*.

Fig. 4. Big Hounds Creek Granite Flatrock. Note vegetation "islands" representing various stages of succession.

Bedrock Geology

Based on the Geologic Map of Virginia (Virginia Division of Mineral Resources, 1993), flatrocks at Seepy, Dundas, Cedar Creek, and Golf Course are porphyroblastic granite gneiss of an undetermined age. This is a "light-gray, medium- to coarse-grained compositionally-layered, well-foliated, commonly lin-eated gneiss composed of metamorphosed granite, leucogranite, and granodiorite which locally contains feldspar megacrysts" (Radar & Evans, 1993). Big Hounds Creek Granite Flatrock is part of the Buggs Island pluton, which is "light-gray medium- to course-grained massive to strongly-foliated biotite-muscovite granite" (Radar & Evans, 1993).

Microhabitats

Granite flatrock plant habitats and their associated communities have been described by several authors, including McVaugh (1943), Burbanck & Platt (1964), Berg (1974), Wyatt & Fowler (1977), Barry (1980), and Quarterman et al. (1993). These include bare rock colonized only by crustose lichens, vegetation mats, shallow depressions, pools, seeps, and marginal (edge) habitats. Granite flatrock communities have been described by Barry (1980) as "a study in succession." Quarterman et al. (1993) divided flatrock community types into "stable plant communities" and "successional plant communities." Other authors who have studied succession on granite flatrocks include Oosting & Anderson (1939), McVaugh (1943), and Burbanck & Platt (1964). Berg (1974) studied succession specifically on Virginia flatrocks.

Many of the plant communities and successional stages which have been documented elsewhere on granite flatrocks are represented at the five new sites. Large areas of exposed bedrock colonized only by crustose lichens

Fig. 5. Golf Course Granite Flatrock. The flatrock is bisected by Cold Spring Branch, located in the middle ground. Note the golf course green in the background.

are a predominate type at all five sites. This is a stable community type, with little, if any, opportunity for the soil accumulation necessary for succession to take place. Two other stable communities discussed by Quarterman

et al. (1993), marginal communities and seepage areas, are also represented at the new sites. Marginal communities are located at the edge of flatrocks in a zone between exposed rock and surrounding forest (or disturbed areas). Soil depth increases from the flatrock edge to the adjacent forest with a corresponding shift in vegetation. Quarterman et al. (1993) reported that marginal communities are relatively stable because soil erosion and accumulation are in close balance. These transitional communities are prominent at all five of the new sites and contain the greatest diversity of plant species.

Well developed seepage areas are located at the southern end of Seepy Granite Flatrock, the northern edge of the principal rock at Dundas Granite Flatrocks, and one of the smaller flatrocks within the Dundas complex. This groundwater seepage typically emerges from an upslope flatrock edge and provides moisture throughout all or much of the growing season to flatrock vegetation mats located lower on the slope. Species associated with seepage at Seepy Granite Flatrock include *Rhexia mariana* (Maryland meadow-beauty), *Eupatorium perfoliatum* (common boneset), *Impatiens capensis* (spotted jewelweed), and *Spiranthes cernua* (nodding ladies'-tresses).

Berg (1974) described a non-successional flatrock community which he refers to as a dry depression. These are shallow, well-drained depressions with little water retention where fine soil particles are washed away, leaving a coarse sandy grit with little organic matter. This community type is absent or poorly developed at the new flatrock sites. Shallow pool communities, another stable community type described by Quarterman et al. (1993), are also absent from the new sites. These are shallow soil communities subject to cycles of submergence to a maximum depth of 15 cm followed by total desiccation. Deeper pools, which retain moisture through all or nearly all of the growing season, however, are found at the Cedar Creek and Golf Course flatrock sites. These pools are fed by groundwater seepage and/or overland flow across sloping bedrock and have soil deep enough to support a lush growth of wetland herbs, such as *Juncus effusus* (soft rush), *Carex intumescens* (bladder sedge), *R. mariana*, *Ptilimnium capillaceum* (mock bishopweed), and *Ludwigia alterniflora* (winged seedbox), and sometimes woody species, particularly *Alnus serrulata* (smooth alder). These pools have many species in common with seepage areas.

Vegetation "islands" comprise the principal successional communities on flatrocks and have been well-documented in the literature. These islands may begin as mats of the moss *Grimmia laevigata*, which are able to retain mineral soil which washes or blows on them (Quarterman et al., 1993). Alternatively, they may begin in depressions with sufficient depth to allow soil accumulation and water retention after rains. Again, however, *G. laevigata*, is the characteristic pioneer species (Berg, 1974). Subsequent early invaders may include *Cladonia* lichens, *Selaginella rupestris* (rock spike-moss), *Talinum teretifolium* (roundleaf fame-flower), and a few annuals such as *Minuartia glabra* (Appalachian sandwort). As soil development continues, *Polytrichum* moss and other annual herbs appear, to be followed by perennial herbs and, finally, by woody species. A number of variations on this basic theme have been reported (Quarterman et al., 1993; Berg, 1974). Because soils underlying well-developed vegetation islands tend to be deepest in the center and shallowest along the edges, vegetation tends to follow a pattern of concentric rings. Woody species, which require deep soils, are found in the center, while species such as *T. teretifolium* , which are adapted to moss mats, are found around the edges (Berg, 1974). Vegetation islands representing various successional stages are found at all five of the new flatrock sites and are particularly well-represented at Big Hounds Creek Granite Flatrock.

Flora

Appendix 1 shows the vascular plant taxa recorded for each of the five flatrock sites. A total of 314 taxa were recorded for the five sites collectively. These lists should be considered preliminary, particularly for Big Hounds Creek and Golf Course granite flatrocks, which were each visited only twice. Nomenclature follows Kartesz (1994) except for the genus *Rubus* (bramble), which follows Gleason & Cronquist (1991). Varieties and subspecies were determined only for selected species. Each taxon was determined to be either native or exotic (non-native) based on Gleason & Cronquist (1991). Approximately 14 percent of the 314 taxa recorded are exotic species.

Twenty-three native species were recorded from all five sites. Herbaceous species in this category are: *Ambrosia artemisiifolia* (common ragweed), *Andropogon virginicus* (broom-sedge), *Asplenium platyneuron* (ebony spleenwort), *Dichanthelium laxiflorum* (open-flower panic grass), *Dichanthelium scoparium* (velvet panic grass), *Diodia teres* (buttonweed), *Krigia virginica* (dwarf-dandelion), *Minuartia glabra*, *Nuttallanthus canadensis* (common toadflax), *Talinum teretifolium*, *Tridens flavus* (redtop), and *Triodanis perfoliata* (Venus'-looking-glass). Woody species recorded from all five sites are: *Acer rubrum* (red maple), *Campsis radicans* (trumpet-creeper), *Crataegus uniflora* (dwarf hawthorne), *Juniperus virginiana*, *Parthenocissus quinquefolia* (Virginia creeper), *Quercus alba*, *Quercus falcata* (Southern red oak), *Quercus rubra* (Northern red oak), *Smilax glauca* (whiteleaf greenbrier), *Smilax rotundifolia*

(common greenbrier), and *Ulmus alata* (winged elm). Forty-nine species were recorded from four of the five sites.

Ten exotic species were recorded from three or more of the five sites. These species are: *Allium vineale* (field garlic), *Bromus* cf. *racemosus* (spiked brome grass), *Cardamine hirsuta* (hairy bittercress), *Commelina communis* (Asiatic dayflower), *Digitaria ischaemum* (smooth crabgrass), *Kummerowia stipulacea* (Japanese bushclover), *Ligustrum sinense*, *Lonicera japonica*, *Rumex acetosella* L. (sheep sorrel), and *Stellaria media* (common chickweed).

Site Significance

Two species of conservation concern were located on flatrocks visited during this study. These are *Portulaca smallii* and *Cyperus granitophilus*. Both species were located near the northern limits of their ranges. *Diamorpha smallii*, previously known from one Virginia site, was not found.

Portulaca smallii, the range of which is restricted to the Piedmont of Georgia, South Carolina, North Carolina, and Virginia, was, until recently, believed to be a strict granite flatrock endemic (Ware, 1991a; S.Q. Croy, unpubl. data). It has now been located on diabase at one site in North Carolina (LeGrande, 1988). Prior to this study, it was known in Virginia from four sites in three counties: Brunswick, Dinwiddie, and Mecklenburg (Harvill, 1976; Ware, 1991a; Harvill et al., 1992; G.P. Fleming, unpubl. data). It is ranked G3 (globally rare) and S1 (extremely rare in Virginia) on the Virginia rare vascular plant list of the Virginia Department of Conservation and Recreation, Division of Natural Heritage (Ludwig, 1997). This species was found at three of the sites visited during this study: Dundas Granite Flatrocks, Big Hounds Creek Granite Flatrock, and Golf Course Granite Flatrock. A collection made at Big Hounds Creek in Lunenburg County represents a county record for this species (Harvill et al., 1992).

Cyperus granitophilus is a wide-ranging southeastern species known from Georgia, Alabama, Tennessee, South Carolina, North Carolina, and Virginia (Kral, 1983; E. Bridges, umpubl. data; Chester et al., 1993). Although most closely associated with granite outcrops, it has been found on a variety of outcrop types, including sandstone (Kral, 1983; E. Bridges, unpubl. data). Prior to this study, it was known in Virginia from four sites in three counties: Brunswick, Mecklenburg, and Nottoway (Harvill, 1976; Ware, 1991b; Harvill et al., 1992; G.P. Fleming, unpubl. data). It is ranked G3Q (a globally rare species of questionable taxonomic status) and S1 (extremely rare in Virginia) on the Virginia rare vascular plant list (Ludwig, 1997). This species was found at two of the sites visited during this study: Dundas Granite Flatrocks and Golf Course Granite Flatrock.

Portulaca smallii and *C. granitophilus* appear to tolerate or even thrive in disturbed areas at the new sites. At Dundas Granite Flatrock, several hundred individuals each of these two species were found in the bed of an old logging road on the southernmost flatrock in the complex. Approximately 25 additional plants of *C. granitophilus* were located within a few square meter area on the principal flatrock at this site, but again in a weedy area which appeared to have past disturbance. No individuals of these species were located on extensive areas of relatively pristine flatrock at the site. At Big Hounds Creek Granite Flatrock, approximately 20 individuals of *P. smallii* were located within a four square meter area on a vegetation mat of moss and *Selaginella rupestris* at a rather weedy corner of the flatrock. Several more individuals were located to the north within a grazed and very weedy woodland of *Juniperus virginiana*. At Golf Course Granite Flatrock, several hundred individuals of *P. smallii* and 50-100 individuals of *C. granitophilus* were located on a small flatrock adjacent to a golf course and other cleared lands. The *Portulaca smallii* population here extends into the frequently mowed lawn of the green, where it appears to be thriving.

Dundas Granite Flatrocks may be the finest known example of an extant granite flatrock in Virginia. This site is comparable in terms of total flatrock acreage to the two largest known flatrocks in the state – Gasburg Granite Flatrock in southern Brunswick County (consisting of three separate flatrocks) and Fine Creek Mills Granite Flatrock in northern Powhatan County. Dundas Granite Flatrock, however, has both fewer invasive exotic species and less overall disturbance than either of these two sites.

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Appendix 1. Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Acalypha gracilens Gray	X	X	X	--	X	--
Acer rubrum L.	X	X	X	X	X	--
Achillea millefolium L.	X	--	X	X	--	--
Agalinis purpurea (L.) Pennell	--	--	X	--	--	--
Agrostis hyemalis (Walt.) B.S.P.	X	X	X	X	--	--
Agrostis perennans (Walt.) Tuckerman	X	X	X	X	--	--
Allium vineale L.	X	X	--	X	X	Y
Alnus serrulata (Ait.) Willd.	--	--	X	--	X	--
Ambrosia artemisiifolia L.	X	X	X	X	X	--
Amelanchier arborea (Michx. f.) Fern.	--	--	X	--	--	--
Andropogon ternarius Michx.	X	--	X	--	X	--
Andropogon virginicus L.	X	X	X	X	X	--
Antennaria parlinii Fern. ssp. *fallax* (Greene) Bayer and Stebbins	--	X	--	--	--	--
Antennaria parlinii Fern. ssp. *parlinii*	X	X	X	--	X	--
Anthoxanthum odoratum L.	--	X	--	--	--	Y
Aphanes microcarpa (Boiss. & Reut.) Rothm.	--	--	--	--	X	Y
Arabidopsis thaliana (L.) Heynh.	X	--	X	--	--	Y
Aristida dichotoma Michx. var. *curtissii* Gray *ex* S. Wats. & Coult.	--	X	--	--	--	--
Aristida dichotoma Michx. var. *dichotoma*	X	--	X	X	X	--
Aristida purpurascens Poir. var. *purpurascens*	X	X	X	--	X	--
Asclepias verticillata L.	--	X	--	--	--	--
Asimina triloba (L.) Dunal	--	--	--	X	--	--
Asplenium platyneuron (L.) B.S.P.	X	X	X	X	X	--
Aster lateriflorus (L.) Britt.	X	--	X	X	X	--
Aster paternus Cronq.	X	--	X	--	--	--
Aster pilosus Willd. var. *demotus* Blake	X	--	--	--	--	--
Aster pilosus Willd. var. *pilosus*	--	X	X	--	--	--
Aster solidagineus Michx.	--	--	X	--	--	--
Athyrium filix -femina (L.) Roth ssp. *asplenioides* (Michx.) Hulten	--	--	X	--	--	--
Barbarea verna (P. Mill.) Aschers.	--	X	--	--	--	Y
Belamcanda chinensis (L.) DC.	--	X	--	--	--	Y
Betula nigra L.	--	--	X	--	--	--
Bidens bipinnata L.	--	X	--	X	--	--
Bidens connata Muhl. ex Willd.	--	--	--	--	X	--
Boehmeria cylindrica (L.) Sw.	--	--	--	X		--
Bromus cf. *racemosus* L.	X	--	X	X	X	Y
Bulbostylis capillaris (L.) Kunth *ex* C.B. Clarke	X	X	--	X	X	--
Callitriche heterophylla Pursh	--	--	--	--	X	--
Campsis radicans (L.) Seem. *ex* Bureau	X	X	X	X	X	--
Cardamine hirsuta L.	X	X	X	X	--	Y
Carex albicans Willd. *ex* Spreng.	X	--	--	--	--	--
Carex atlantica Bailey	--	--	X	--	X	--
Carex cephalophora Muhl. *ex* Willd.	--	--	X	X	--	--
Carex crinita Lam.	--	--	X	--	X	--
Carex hirsutella Mackenzie	X	X	--	X	--	--
Carex intumescens Rudge	--	--	X	--	--	--
Carex longii Mackenzie	--	--	--	X	X	--
Carex lurida Wahlenb.	--	--	X	--	--	--
Carex swanii (Fern.) Mackenzie	--	--	--	X	--	--
Carex umbellata Schkuhr *ex* Willd.	X	X	X	X	--	--
Carpinus caroliniana Walt.	--	--	X	X	X	--
Carya alba (L.) Nutt. *ex* Ell.	--	X	X	X	--	--

Appendix 1 (continued). Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Carya glabra (P. Mill.) Sweet	X	X	X	X	--	--
Ceanothus americanus L.	--	X	--	--	--	--
Celtis occidentalis L.	--	X	X	X	--	--
Centaurea biebersteinii DC.	--	X	--	--	--	Y
Cephalanthus occidentalis L.	--	--	X	--	--	--
Cerastium semidecandrum L.	--	--	--	X	--	Y
Cercis canadensis L.	--	--	X	--	--	--
Chaerophyllum tainturieri Hook	--	--	--	X	--	--
Chamaecrista nictitans (L.) Moench	X	X	X	--	--	--
Chasmanthium laxum (L.) Yates var. *laxum*	--	X	X	--	X	--
Cheilanthes lanosa (Michx.) D.C. Eat.	--	--	X	--	--	--
Chionanthus virginicus L.	X	--	X	X	--	--
Chrysopsis mariana (L.) Ell.	X	--	X	--	--	--
Cicuta maculata L.	--	--	X	--	--	--
Clematis ochroleuca Ait.	--	--	X	--	--	--
Clitoria mariana L.	--	X	X	X	--	--
Commelina communis L.	--	X	X	X	X	Y
Conyza canadensis (L.) Cronq.	X	X	--	--	X	--
Cornus florida L.	--	--	X	--	X	--
Crataegus uniflora Muenchh.	X	X	X	X	X	--
Crotalaria sagittalis L.	X	--	--	--	--	--
Croton glandulosus L. var. *septentrionalis* Muell.-Arg.	--	--	--	X	--	--
Croton willdenowii Webster	X	X	X	X	--	--
Cunila origanoides (L.)Britt.	--	X	--	--	--	--
Cuscuta compacta Juss. *ex* Choisy	--	--	X	--	--	--
Cyperus granitophilus McVaugh	--	X	--	--	X	--
Cyperus pseudovegetus Steud.	--	--	X	--	--	--
Cyperus strigosus L.	--	X	X	X	X	--
Dactylis glomerata L.	--	--	--	X	--	Y
Danthonia sericea Nutt.	--	--	--	X	--	--
Danthonia spicata (L.) Beauv. *ex* Roemer & J.A. Schultes	X	X	X	X	--	--
Desmodium paniculatum (L.) DC.	--	--	X	--	--	--
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*	--	X	X	--	--	--
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann	--	X	X	X	--	--
Dichanthelium boscii (Poir.) Gould & C.A. Clark	--	X	X	X	--	--
Dichanthelium clandestinum (L.) Gould	X	--	X	X	X	--
Dichanthelium sabulorum (Lam.) Gould & C.A. Clark var. *thinium* (A.S. Hitchc. & Chase) Gould & C.A. Clark	--	--	--	--	X	--
Dichanthelium commutatum (J.A. Schultes) Gould	--	X	X	--	--	--
Dichanthelium depauperatum (Muhl.) Gould	X	X	--	X	--	--
Dichanthelium dichotomum (L.) Gould var. *dichotomum*	X	X	X	--	X	--
Dichanthelium laxiflorum (Lam.) Gould	X	X	X	X	X	--
Dichanthelium scoparium (Lam.) Gould	X	X	X	X	X	--
Dichanthelium sphaerocarpon (Ell.) Gould var. *isophyllum* (Scribn.) Gould	X	X	X	--	--	--
Dichanthelium sphaerocarpon (Ell.) Gould var. *sphaerocarpon*	X	X	--	--	--	--
Digitaria ischaemum (Schreb.) Muhl.	X	X	--	X	X	Y
Diodia teres Walt.	X	X	X	X	X	--
Diospyros virginiana L.	--	X	X	--	--	--
Eleocharis cf. *tenuis* (Willd.) J.A. Schultes	X	--	--	--	--	--
Eleocharis obtusa (Willd.) J.A. Schultes	--	--	X		X	--
Elephantopus carolinianus Raeusch.	--	--	--	X	--	--
Elephantopus tomentosus L.	X	--	X	X	--	--

Appendix 1 (continued). Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Eleusine indica (L.) Gaertn.	--	--	--	--	X	Y
Elymus virginicus L.	X	--	X	--	--	--
Eragrostis capillaris (L.) Nees	--	X	--	--	--	--
Eragrostis hirsuta (Michx.) Nees	--	X	--	X	X	--
Erechtites hieraciifolia (L.) Raf. *ex* DC.	X	X	X	X	--	--
Erigeron strigosus Muhl. *ex* Willd.	X	X	X	X	--	--
Erythronium umbilicatum Parks and Hardin	--	X	X	--	--	--
Eupatorium capillifolium (Lam.) Small	X	--	X	--	X	--
Eupatorium fistulosum Barratt	--	--	X	--	X	--
Eupatorium godfreyanum Cronq.	--	X	X	--	--	--
Eupatorium hyssopifolium L.	X	X	X	--	--	--
Eupatorium perfoliatum L.	X	--	X	X	--	--
Eupatorium rotundifolium L. var. *ovatum* (Bigelow) Torr.	X	X	--	--	--	--
Euphorbia corollata L.	--	X	--	--	--	--
Euthamia tenuifolia (Pursh) Nutt.	--	X	--	--	--	--
Evonymus americana L.	X	X	X	--	X	--
Festuca pratensis Huds.	--	--	--	X	--	Y
Fimbristylis autumnalis (L.) Roemer & J.A. Schultes	X	X	--	--	--	--
Fraxinus americana L.	--	X	--	X	--	--
Galium aparine L.	--	X	X	X	--	--
Galium pilosum Ait.	X	X	X	--	--	--
Galium tinctorium (L.) Scop.	--	--	X	--	--	--
Gamochaeta purpurea (L.) Cabrera	X	--	--	X	X	--
Gaylussacia baccata (Wangenh.) K. Koch	--	X	--	--	--	--
Gelsemium sempervirens St.-Hil.	--	--	--	--	X	--
Geranium carolinianum L.	X	--	X	X	X	--
Geranium dissectum L.	--	--	--	X	--	Y
Glechoma hederacea L.	--	--	--	X	--	Y
Gnaphalium obtusifolium L.	X	X	--	--	--	--
Gymnopogon ambiguus (Michx.) B.S.P.	--		X	--	--	--
Hedeoma pulegioides (L.) Pers.	--	X	--	X	--	--
Helenium amarum (Raf.) H. Rock	--	--	--	--	X	--
Helenium flexuosum Raf.	X	--	--	--	--	--
Helianthus divaricatus L.	--	--	--	X	--	--
Heuchera americana L.	--	--	X	--	X	--
Hexastylis sp.	--	--	X	--	--	--
Hieracium gronovii L.	--	--	X	--	--	--
Hieracium venosum L.	--	X	--	--	--	--
Houstonia caerulea L.	X	X	X	--	--	--
Houstonia longifolia Gaertn. var. *longifolia*	--	---	X	--	--	--
Houstonia longifolia Gaertn. var. *tenuifolia* (Nutt.) Wood	X	X	X	--	--	--
Hypericum gentianoides (L.) B.S.P.	X	X	X	--	X	--
Hypericum hypericoides (L.) Crantz ssp. *hypericoides*	--	--	--	--	X	--
Hypericum hypericoides (L.) Crantz ssp. *multicaule* (Michx. *ex* Willd.) Robson	X	X	X	--	--	--
Hypericum mutilum L.	--	--	X	--	--	--
Hypericum nudiflorum Michx. *ex* Willd.	--	--	X	--	--	--
Hypericum punctatum Lam.	X	--	X	--	--	--
Ilex opaca Ait.	--	X	X	X	X	--
Impatiens capensis Meerb.	X	--	X	X	X	--
Juglans nigra L.	--	X	--	X	--	--
Juncus acuminatus Michx.	X	--	X	--	X	--
Juncus biflorus Ell.	X	--	--	--	X	--

Appendix 1 (continued). Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Juncus canadensis J. Gay *ex* Laharpe	--	--	X	--	--	--
Juncus coriaceus Mackenzie	X	--	X	--	X	--
Juncus dichotomus Ell.	--	X	X	X	X	--
Juncus effusus L.	--	--	X	--	X	--
Juncus marginatus Rostk.	X	--	X	--	--	--
Juniperus virginiana L.	X	X	X	X	X	--
Krigia dandelion (L.) Nutt.	--	X	--	X	X	--
Krigia virginica (L.) Willd.	X	X	X	X	X	--
Kummerowia stipulacea (Maxim.) Makino	X	X	X	--	--	Y
Kyllinga pumila Michx.	--	--	--	--	X	--
Lamium amplexicaule L.	--	--	--	--	X	Y
Lechea racemulosa Michx.	X	X	X	X	--	--
Leersia virginica Willd.	--	X	--	--	--	--
Lepidium virginicum L.	--	X	--	X	--	--
Lespedeza cuneata (Dum.-Cours.) G. Don	--	X	X	--	--	Y
Lespedeza repens (L.) W. Bart.	X	X	X	--	--	--
Leucanthemum vulgare Lam.	--	X	--	X	--	Y
Leucothoe racemosa (L.) Gray	--	--	X	--	--	--
Ligustrum sinense Lour.	--	X	--	X	X	Y
Lindernia dubia (L.) Pennell var. *dubia*	--	--	X	--	--	--
Linum striatum Walt.	--	--	X	--	--	--
Liquidambar styraciflua L.	X	X	X	--	X	--
Liriodendron tulipifera L.	--	X	X	--	--	--
Lithospermum canescens (Michx.) Lehm.	--	--	--	X	--	--
Lonicera japonica Thunb.	X	X	X	--	X	Y
Lonicera sempervirens L.	--	--	--	--	X	--
Ludwigia alternifolia L.	--	--	X	--	X	--
Ludwigia decurrens Walt.	--	--	X	--	--	--
Ludwigia palustris (L.) Ell.	--	--	X	--	--	--
Luzula bulbosa (Wood) Smyth & Smyth	X	--	X	--	--	--
Lycopus virginicus L.	--	--	X	--	--	--
Matelea sp.	--	--	X	--	--	--
Melica mutica Walt.	--	--	--	X	--	--
Microstegium vimineum (Trin.) A. Camus	--	--	X	--	--	Y
Minuartia glabra (Michx.) Mattf.	X	X	X	X	X	--
Mollugo verticillata L.	--	X	--	--	--	Y
Morus rubra L.	--	X	--	--	--	--
Muhlenbergia schreberi J.F. Gmel.	X	--	--	X	--	--
Murdannia keisak (Hassk.) Hand.-Maz.	--	--	X	--	--	Y
Nuttallanthus canadensis (L.) D.A. Sutton	X	X	X	X	X	--
Nyssa biflora Walt.	--	X	X	--	--	--
Oenothera laciniata Hill	--	--	--	X	--	--
Opuntia humifusa (Raf.) Raf.	X	X	X	X	--	--
Oxalis dillenii Jacq.	X	X	--	--	X	--
Oxalis stricta L.	X	X	--	X	--	--
Oxalis violacea L.	X	X	X	--	--	--
Oxydendrum arboreum (L.) DC.	--	--	X	--	--	--
Panicum anceps Michx.	X	X	X	--	X	--
Panicum dichotomiflorum Michx.	X	X	X	--	X	--
Panicum philadelphicum Bernh. *ex* Trin.	X	X	--	--	--	--
Parthenocissus quinquefolia (L.) Planch.	X	X	X	X	X	--
Paspalum laeve Michx.	X	--	--	X	X	--
Paspalum setaceum Michx.	--	X	X	--	--	--

Appendix 1 (continued). Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Peltandra virginica (L.) Schott	X	--	X	--	--	--
Penstemon laevigatus Ait.	X	--	--	--	--	--
Phytolacca americana L.	--	X	X	X	--	--
Pinus taeda L.	X	X	X	--	X	--
Pinus virginiana P. Mill.	X	--	X	--	--	--
Piptochaetium avenaceum (L.) Parodi	--	X	--	X	--	--
Plantago aristata Michx.	--	X	--	--	--	Y
Plantago virginica L.	X	X	--	X	X	--
Platanus occidentalis L.	--	--	X	--	--	--
Poa annua L.	--	--	X	--	X	Y
Poa compressa L.	--	--	--	X	--	Y
Poa pratensis L.	--	--	--	X	--	Y
Polygonatum biflorum (Walt.) Ell.	--	X	X	--	--	--
Polygonum caespitosum Blume var. *longisetum* (de Bruyn) A.N. Steward	--	--	X	X	--	Y
Polygonum punctatum Ell.	--	--	X	--	--	--
Polygonum sagittatum L.	--	--	X	--	X	--
Polypodium virginianum L.	--	--	X	--	--	--
Portulaca smallii P. Wilson	--	X	--	X	X	--
Potentilla canadensis L.	X	X	X	X	--	--
Potentilla simplex Michx.	--	--	--	--	X	--
Prunella vulgaris L.	X	--	--	--	--	Y?
Prunus serotina Ehrh.	X	--	X	--	X	--
Ptilimnium capillaceum (Michx.) Raf.	--	--	--	--	X	--
Pycnanthemum tenuifolium Schrad.	X	--	X	--	--	--
Quercus alba L.	X	X	X	X	X	--
Quercus falcata Michx.	X	X	X	X	X	--
Quercus prinus L.	--	X	X	--	--	--
Quercus phellos L.	--	X	--	X	X	--
Quercus rubra L.	X	X	X	X	X	--
Quercus stellata Wangenh.	X	X	X	--	--	--
Ranunculus pusillus Poir.	--	--	--	--	X	--
Rhexia mariana L. var. *mariana*	X	--	X	X	X	--
Rhododendron periclymenoides (Michx.) Shinners	--	--	X	--	--	--
Rhus aromatica Ait.	--	X	X	X	--	--
Rhus copallinum L. var. *latifolia* Engl.	X	X	X	X	--	--
Rhynchospora capitellata (Michx.) Vahl	X	--	X	--	X	--
Rhynchospora globularis (Chapman) Small var. *globularis*	X	X	--	--	--	--
Rosa carolina L.	X	X	X	X	--	--
Rosa multiflora Thunb. *ex* Murr.	--	--	--	X	--	Y
Rubus allegheniensis Porter	--	X	--	--	--	--
Rubus argutus Link	X	--	--	--	X	--
Rubus enslenii Tratt.	X	--	X	X	X	--
Rubus occidentalis L.	X	X	--	--	--	--
Rubus pensilvanicus Poir.	--	X	--	X	--	--
Ruellia caroliniensis (J.F. Gmel.) Steud.	X	--	--	--	--	--
Rumex acetosella L.	X	X	X	X	--	Y
Rumex crispus L.	--	--	--	X	--	Y
Salix sericea Marsh.	--	--	X	--	--	--
Salvia lyrata L.	X	--	X	--	--	--
Saxifraga virginiensis Michx.	--	X	X	X	--	--
Schizachyrium scoparium (Michx.) Nash	X	X	X	X	--	--
Scirpus georgianus Harper	X	--	--	--	--	--

Appendix 1 (continued). Vascular plant taxa recorded from five granite flatrock sites in Virginia's southern Piedmont.

Taxon	Seepy	Dundas	Cedar Creek	Big Hounds	Golf Course	Exotic? Y=Yes
Sclerantlius annuus L.	--	--	X	--	--	Y
Scleria oligantha Michx.	--	X	--	--	--	--
Scleria pauciflora Muhl. *ex* Willd. var. *pauciflora*	--	X	--	--	--	--
Scutellaria integrifolia L.	X	X	X	--	X	--
Selaginella rupestris (L.) Spring	--	X	--	X	--	--
Senecio anonymus Wood	X	X	X	--	X	--
Setaria glauca (L.) Beauv.	X	--	--	--	--	Y
Silene caroliniana Walt. ssp. *pensylvanica* (Michx.) Clausen	--	X	X	X	--	--
Silene virginica L.	--	--	--	X	--	--
Smilax bona-nox L.	--	X	--	X	X	--
Smilax glauca Walt.	X	X	X	X	X	--
Smilax rotundifolia L.	X	X	X	X	X	--
Solanum carolinense L.	X	--	--	X	--	--
Solidago caesia L. var. *caesia*	--	--	X	--	--	--
Solidago nemoralis Ait.	--	X	--	--	--	--
Solidago pinetorum Small	X	X	X	--	--	--
Solidago rugosa P. Mill.	X	--	X	--	X	--
Solidago speciosa Nutt. var. *erecta* (Pursh) MacM.	--	X	X	--	--	--
Sorghastrum nutans (L.) Nash	--	X	X	--	--	--
Spiranthes cernua (L.) L.C. Rich.	X	--	X	--	--	--
Stellaria media (L.) Vill.	X	--	X	X	X	Y
Stylosanthes biflora (L.) B.S.P.	X	X	X	--	--	--
Symphoricarpos orbiculatus Moench	--	--	--	--	X	--
Talinum teretifolium Pursh	X	X	X	X	X	--
Thalictrum sp.	--	--	X	--	--	--
Tipularia discolor (Pursh) Nutt.	--	--	X	--	--	--
Toxicodendron radicans (L.) Kuntze	X	--	X	X	X	--
Trichostema dichotomum L.	--	--	--	X	X	--
Tridens flavus (L.) A.S. Hitchc.	X	X	X	X	X	--
Trifolium arvense L.	--	--	--	X	--	Y
Trifolium campestre Schreb.	--	--	--	X	--	Y
Trifolium dubium Sibthorp	--	--	--	X	--	Y
Triodanis perfoliata (L.) Nieuwl.	X	X	X	X	X	--
Typha sp.	--	--	--	--	X	--
Ulmus alata Michx.	X	X	X	X	X	--
Uvularia sessilifolia L.	--	X	--	X	--	--
Vaccinium corymbosum L.	X	--	X	--	X	--
Vaccinium pallidum Ait.	--	X	X	--	--	--
Vaccinium stamineum L.	X	X	X	--	X	--
Valerianella radiata (L.) Dufr.	--	--	X	--	X	--
Verbascum thapsus L.	--	X	X	--	--	Y
Verbesina occidentalis (L.) Walt.	--	--	--	X	--	--
Veronica arvensis L.	--	X	X	--	--	Y
Veronica peregrina L.	--	--	X	--	X	--
Viburnum prunifolium L.	--	X	X	X	--	--
Vicia sp.	--	--	--	X	--	?
Viola arvensis Murr.	--	X	--	--	X	Y
Viola bicolor Pursh	X	X	--	--	X	--
Viola palmata L. var. *triloba* (Schwein.) Gingins *ex* DC.	X	--	--	--	--	--
Vitis cinerea (Engelm.) Millard var. *floridana* Munson	--	X	--	--	--	--
Vitis rotundifolia Michx.	X	X	X	--	X	--
Vulpia octoflora (Walt.) Rydb.	--	--	--	X	--	--
Woodsia obtusa (Spreng.) Torr.	--	X	X	X	--	--
Yucca filamentosa L.	--	--	X	--	--	?
TOTALS: 314	135	159	194	128	112	ca. 45

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Annotated Checklist of the Amphibians and Reptiles of Fort A.P. Hill, Virginia, and Vicinity

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INTRODUCTION

The geographic location of Fort A.P. Hill in the Coastal Plain of Virginia and the diversity of terrestrial and aquatic habitats within this military reservation results in a diverse flora and fauna for this area. Several species of amphibians and reptiles that reach the northern limits of their ranges in eastern Virginia and southern Maryland occur here (Harris, 1975; Tobey, 1985; Mitchell, 1994; Roble, 1995). The freshwater wetlands on Fort A.P. Hill provide abundant habitat for salamanders and frogs, environmentally sensitive animals that have been declining worldwide (Blaustein & Wake, 1990; Phillips, 1990; Wyman, 1990; Blaustein et al., 1994; Wake, 1994). These wetlands also harbor several species of freshwater turtles. The range of terrestrial communities from bottomland hardwood forests to mixed pine and hardwood stands to a variety of grasslands offers habitats for snakes and lizards. Taken together, the natural environment contained within the boundaries of Fort A.P. Hill should support numerous species of amphibians and reptiles.

The herpetofauna of Fort A.P. Hill has not been completely surveyed. Brittle (1969a, b, 1970) summarized the species known for Caroline County, Virginia, at that time. Brief notations on elements of the herpetofauna on the base have been reported by Collins (1966), Hayslett (1995), Roble (1994, 1995), and Roble & Hobson (1994, 1996).

Rare species occurrences documented by the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DNH) during a 1992-1993 survey of the base were summarized by Fleming & Van Alstine (1994). On 28-30 April 1995, the Virginia Herpetological Society (VHS) held its spring field trip meeting on Fort A.P. Hill and made excursions into parts of the Wildlife Refuge, an area set aside from training, and the vicinity of Jordon Crossing Pond (Training Areas 7A and 7B). They recorded observations on 8 species of frogs and toads, 6 salamanders, 4 turtles, 3 lizards, and 5 snakes (Hayslett, 1995). Additional information on these animals has been accumulated by JCM while working under the auspices of the Division of Natural Heritage (1992) and, more recently, under contracts from the US Department of Defense (Legacy Program) and Fort A.P. Hill. DNH personnel recorded observations on amphibians and reptiles during surveys for rare species in 1992-1995. All of the existing information on the amphibians and reptiles of Fort A.P. Hill has not been assembled in one place and therefore hinders the development and implementation of effective management plans that deal with these animals. Here we summarize some of the information available on the distribution and natural history of the herpetofauna of Fort A.P. Hill in an annotated checklist format.

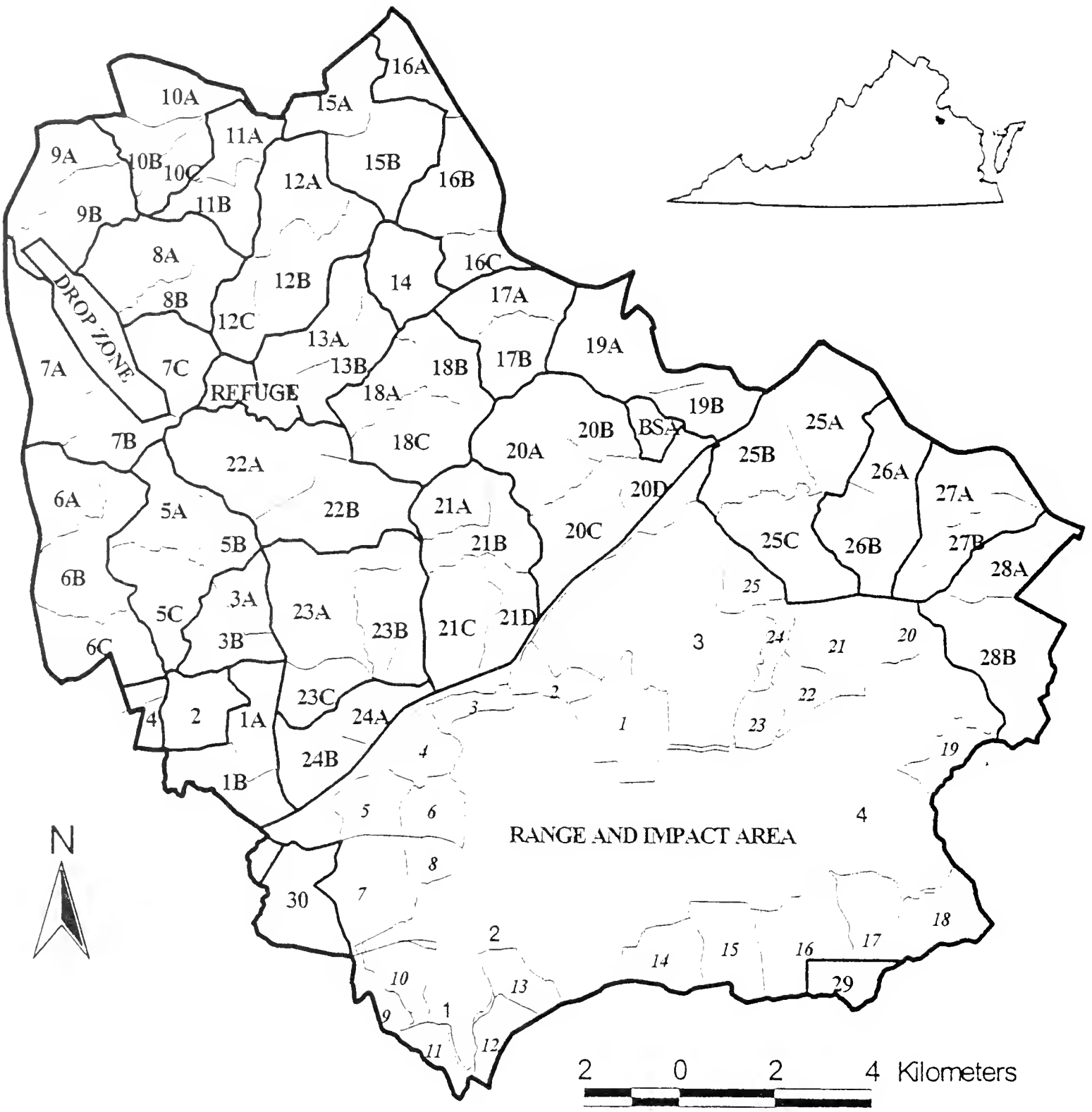

Fig 1 Map of Fort A.P Hill, Caroline County, Virginia. Training areas (TA) and Controlled Access areas (CA) are outlined and numbered Selected sites in the Impact Area are numbered. The Refuge is the Wildlife Refuge and BSA is an area set aside for the Boy Scouts of America that includes Herns Pond.

DESCRIPTION OF FORT A.P. HILL

Fort A.P. Hill Military Reservation (US Army) was established for military training in June 1941 and named in honor of Civil War Confederate Lieutenant General Ambrose Powell Hill. It lies in the northwestern portion of Caroline County, Virginia and contains 30,734 ha (75,944 acres) of federally owned land and 45 ha leased from private land owners. Fewer than 40.5 ha lie within Essex County. US Route 301 essentially divides the base into north and south sections (Fig. 1). The lands available for direct access training, and our field activities, are divided into 30 Training Areas (TA), most of which occur north of US Rt. 301. An additional 25 Controlled Access (CA) areas occur south of US Rt. 301 around the periphery of the Impact Area. This portion of the base receives live ordnance from artillery and helicopter firing exercises. These areas may be accessed by some personnel only on a limited basis due to the potential hazards of unexploded ordnance. This leaves much of the land south of US Rt. 301 unmanaged with restricted impact by humans. The majority of the base is currently used for infantry-related training activities. Only the Impact Area was off-limits to field research, although a few records were obtained by Division of Natural Heritage (DNH) personnel who had limited access and by base personnel who provided observations or specimens to JCM. An active game management program occurs on base, and hunting for deer, turkey, dove, squirrels, and rabbits is encouraged. Game fish are stocked in some impoundments where limited fishing is allowed. Fort A.P. Hill has hosted the Boy Scouts of America National Jamboree every four years since 1981.

Elevation on Fort A.P. Hill ranges from 6.1 to 76 m. The topography in the Mattaponi River watershed in the southwestern third of the base is generally flat with low, gentle slopes on the uplands among the streams and wetlands. Topographic relief increases sharply in portions of the Rappahannock River watershed in the eastern and northeastern two-thirds of the base with steep ravines and ridges bisected by streams. Both drainages lie within the Coastal Plain.

Prior to the establishment of the base in 1941, the land was used for extensive farming and timber harvesting. Dominant forest communities are loblolly pine (*Pinus taeda*), Virginia pine (*Pinus virginiana*), mixed hardwood-pine, and various combinations of hardwood trees (*Acer rubrum*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Liquidambar styraciflua*, *Quercus alba*, *Q. coccinea*, *Q. michauxii*, *Q. ruber*, Q. *velutina*). The base is currently about 80% forested from natural regrowth and forestry management. The forestry program focuses on the establishment of loblolly pine plantations and management of a variety of forest cover types. Early successional stages (grasslands) are abundant here under maintained (mowed regularly) and unmaintained (unmowed) management programs. Some of the latter are managed extensively by burning and discing to provide wildlife food plots. Numerous naturally-acidic wetlands, including vernal pools, streams, beaver ponds, and manmade impoundments occur on the base. Permanent buildings occur in clusters and troops bivouac in a variety of forested and grassland sites.

MATERIALS AND METHODS

The current information base on the amphibians and reptiles of Fort A.P. Hill lies in specimens housed in museum and university collections, in files of researchers and the Division of Natural Heritage, the Fish and Wildlife Information Exchange program at Virginia Polytechnic Institute & State University (in conjunction with JCM's research program), and in the literature. JCM examined all museum specimens to verify identification and for information on collection site and date. Museum abbreviations used in this paper are Museum of Natural History, University of Kansas (KU), National Museum of Natural History (USNM), Virginia Commonwealth University (VCU), Virginia Museum of Natural History (VMNH). The VCU specimens were donated by Dale Brittle in 1973 (Brittle, 1969a, b, 1970; Mitchell, 1973). Information presented in this paper is derived from observations made through 1997.

We obtained data on breeding periods of frogs and toads by noting records of species-specific vocalizations when we were in the field. We determined seasonal activity periods of terrestrial salamanders by overturning and replacing surface objects such as logs and rocks during numerous transects. We used aquatic dip nets and minnow traps to obtain frogs and salamanders and their larvae in selected wetlands. We caught freshwater turtles with funnel traps made of chickenwire, following Iverson (1979), and standard commercial hoop traps with netting. Many individuals caught were marked following the technique described in Mitchell (1988). All individuals found alive or dead on roads and those observed incidentally were recorded.

One locality (Finnegan) noted for Fort A.P. Hill in several of the museum records from the University of Kansas cannot be located on existing maps of the base nor in the gazetteer for Virginia (Biggs, 1974). Patrick Jones (A.P. Hill staff, personal communication) pointed out that this site has been known locally as Finnegan Field, and is located near Delos on the south side of US Rt. 301 (Table 1). We have used this modification of the site name here. Also, the notation of Herns Pond for several USNM specimens uses the spelling "Hearnes" Pond, a local family name and probable former owner of that area. We

have corrected the spelling to its current usage for this checklist.

Table 1. Gazetteer of museum collection locations mentioned in the text. The point of reference is the main gate to Fort A.P. Hill (APH) on US Route 301, 2.7 km NE of the center of Bowling Green. All locations are in Caroline County, Virginia.

LOCALITY	DISTANCE & DIRECTION
Alps	17 km SE APH gate
Bowling Green	2.7 km SW APH gate
Corbin	15 km NW APH gate
DeJarnette	9 km SE APH gate
Finnegan Field	5.5 km NE APH gate
Guiney (Station)	3 km NW APH gate
Milford	6 km SW APH gate
Olney	18 km N APH gate
Pettigrew	16 km NNE APH gate
Rappahannock Academy	13 km NE APH gate
Rodes	7.6 km NNE APH gate
Sparta	12.5 km S APH gate
Woodford	9 km NW APH gate

RESULTS

A total of 28 amphibians and 31 reptiles are known to occur on or near Fort A.P. Hill in the northern portion of Caroline County. Fifteen frogs and toads, 13 salamanders, 8 turtles, 5 lizards, and 18 snakes have been confirmed through 1997. The following species accounts summarize known voucher specimens in museum collections and miscellaneous observational data obtained by DNH personnel and JCM. Museum locality records are included in the gazetteer (Table 1). Training Areas (TA), Controlled Access areas (CA), and other areas noted for each species are mapped in Fig. 1.

Amphibians

1. *Acris crepitans crepitans* (Northern cricket frog) - [TA 1A, 1B, 2, 3A, 3B, 5A, 5B, 5C, 6A, 6B, 7A, 7B, 7C, 8A, 9A, 9B, 10A, 10B, 12A, 13A, 13B, 15B, 16B, 18B, 20A, 21A, 21B, 21D, 22A, 22B, 23A, 23B, 23C, 24A, 24B, 25A, 25B, 25C, 26A, 26B, 27A, 27B, 28A, 28B, 30 BSA, Drop Zone, Refuge; CA 5, 6, 7, 11, 12, 15, 21, 23, 24; Impact sites 1,2]

Cricket frogs are widespread and abundant in most types of wetlands on the base, including beaver ponds, vernal pools, and reservoirs. Specimens were collected from Herns Pond (located between TA 20B and 20D, area BSA in Fig. 1) on 20 March 1976 (USNM 203051-52) and from Lonesome Gulch Pond (TA 3B) on 1 November 1992 and 8 July 1996 (VMNH uncataloged). The earliest date of observation is 12 April and the latest is 22 November. Calling dates are 18 April - 4 August. Metamorphs were observed on 8 July 1994.

2. *Bufo americanus americanus* (American toad) - [TA 1B, 2, 3A, 3B, 5A, 5B, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 10B, 10C, 11A, 12A, 12B, 12C, 13, 15B, 16B, 18A, 20A, 20B, 20C, 20D, 21D, 22A, 22B, 23B, 23C, 25A, 25B, 25C, 27B, 28A, 28B, 30, Drop Zone, Refuge; CA 15; Impact sites 2, 3]

Four specimens were collected on 20 March 1976 in the vicinity of Herns Pond (USNM 203047-50). This species is locally abundant, especially at the start of the breeding season. The earliest calling and breeding record is 21 February 1997. Breeding occurs during rainy periods between late-February and mid-April.

3. *Bufo fowleri* (Fowler's toad) - [TA 1B, 3A, 3B, 5A, 5C, 6A, 7A, 7B, 7C, 8A, 9B, 10B, 12B, 15B,16B, 20B, 21D, 22A, 23C, 24A, 25A, 25B, 26A, 26B, 28B, 30, Drop Zone; Impact site 2]

This anuran has not yet been found in large choruses but is commonly encountered on roads on wet nights in late-spring and summer. Males call sporadically during late April through July and occasionally in August. The earliest record is 26 April 1997. Numerous recently metamorphosed juveniles were observed on 8 July 1994 and 20 June 1997 in shallow pools in dirt roads.

4. *Gastrophryne carolinensis* (Eastern Narrow-mouthed toad) - [TA 9A, 22A; CA 11, 12]

This small, fossorial frog has been encountered in only four sites on base, all during summer months. Adults lay eggs in shallow water depressions in open fields and roadside ditches. Dates of calling males include 25 April and 26 May. Other locality records are based on larval identifications.

5. *Hyla chrysoscelis* (Cope's gray treefrog) - [TA 1B, 2, 3A, 3B, 4, 5A, 5B, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 8B, 9A, 9B, 10B, 10C, 11A, 12A, 12B, 12C, 13B, 15A, 15B, 16B, 16C, 17A, 18C, 20A, 20B, 20D, 21A, 21B, 21C, 21D, 22A, 22B, 23A, 23B, 23C, 24A, 24B, 25A, 25B, 25C, 26A, 26B, 27A, 28A, 28B, 30, Drop Zone, Refuge; CA 5, 11, 12, 14, 15, 23, 24]

One specimen was collected at Herns Pond on 20 March 1976 (USNM 203060). This species is common throughout the base and found around nearly all ponds and many vernal pools. Known calling dates are between 18 April - 8 July. We have evaluated gray treefrog vocalizations by ear and recordings of calls throughout Fort A.P. Hill; none were *Hyla versicolor*.

6. *Hyla cinerea* (Green treefrog) - [TA 18B, 25A]

Only two locations have been verified for this anuran (Roble, 1994; VMNH 6758-60). Males were heard chorusing on 2 July 1992 and 7-8 July 1994.

7. *Pseudacris crucifer crucifer* (Spring peeper) - [TA 1A, 1B, 2, 3B, 5A, 5B, 5C, 6A, 6B, 7A, 7B, 7B, 8A, 8B, 9A, 9B, 10A, 10B, 12C, 13B, 16B, 18C, 14, 20A, 20B, 20D, 21B, 21C, 21D, 22A, 22B, 23A, 24B, 25A, 27A, 27B, 28A, 28B, Drop Zone, Refuge; CA 12, 21, 24]

This is a common frog throughout Fort A.P. Hill that is often heard calling from wetlands from late-February through mid-April. Seven specimens were collected from Herns Pond on 20 March 1976 (USNM 203053-59). The earliest calling date was 20 February 1997. Males call sporadically from refugia in trees or ground-level sites through April and in fall and winter months during cool weather. Mating was observed on 29 March 1994. Recent metamorphs were found on 24 June 1994.

8. *Pseudacris triseriata feriarum* (Upland chorus frog) - [TA 7A, 25A, 25B]

We have few records of this species on base. Several males were heard calling from roadside ditches on 29 March 1994 and 21 February 1997; an amplexed pair was observed on the latter date.

9. *Rana catesbeiana* (Bullfrog) - [TA 1A, 2, 3B, 5A, 5C, 6A, 6B, 7A, 7B, 7C, 8B, 9B, 10A, 11A, 12B, 13A, 14, 18C, 20A, 20B, 20C, 20D, 21D, 22A, 23B, 23C, 25A, 24B, 25A, 26B, 27B, 28A, 30, Refuge; CA 5, 11, 12, 15, 24; Impact site 2]

Bullfrogs are widespread on the base and can be found at many beaver ponds, all the reservoirs, and along some streams. One specimen was collected on 20 March 1976 at Herns Pond (USNM 203060). Early and late dates of observation are 15 March and 17 October. Inclusive calling dates are 25 April - 8 July.

10. *Rana clamitans melanota* (Green frog) - [TA 1A, 1B, 2, 3A, 3B, 4B, 5A, 5C, 6A, 6B, 7A, 7B, 7C, 8A, 9A, 9B, 10A, 10B, 10C, 11A, 11B, 12A, 12B, 12C, 13A, 13B, 14, 15A, 15B, 16B, 17A, 18B, 18C, 20A, 20B, 20C, 20D, 21B, 21C, 21D, 22A, 22B, 23A, 23B, 23C, 24A, 24B, 25A, 25C, 26A, 27A, 27B, 28A, 30, Refuge; CA 5, 6, 7, 11, 12, 15, 24; Impact sites 2, 4]

This frog occurs widely on Fort A.P. Hill and is found in most of the freshwater wetlands, including beaver ponds, marshes, lakes, streams, and vernal pools. The first specimen collected in the vicinity was found on 20 February 1939 at Woodford (USNM 127466). Other specimens were collected on 10-11 July 1963 at Finnegan Field (KU 156219-20) and on 20 March 1976 at Herns Pond (USNM 203061). Early and late dates of active individuals are 20 February and 15 November. Inclusive calling dates are 25 April - 8 July. One juvenile found in a boggy seepage habitat at the headwaters of Peumansend Creek in CA 6 by C.S. Hobson and SMR on 4 October 1994 had a deformed mouth and an incomplete snout. Several other juveniles captured at the same site were normal.

11. *Rana palustris* (Pickerel frog) - [TA 1B, 2, 3B, 5A, 5C, 6B, 7B, 10B, 11B, 13A, 13B, 14, 15B, 20D, 21A, 21D, 22A, 22B, 25A, 25C, 30, BSA, Refuge; Impact site 1]

Pickerel frogs appear to be less common than other ranids, but have been found at several beaver ponds, road rut puddles, and along streams (including several sites along Mill Creek). Early and late activity dates are 28 April and 14 October. Male vocalizations were heard from 27 March to 16 September. Many recently metamorphosed juveniles were found on 24 June 1994.

12. *Rana sylvatica* (Wood frog) - [TA 1B, 4, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 10A, 10B, 11A, 12A, 12B, 12C, 14, 15A, 15B, 16B, 18C, 20A, 20B, 20C, 20D, 21A, 21B, 23A, 23B, 25A, 25B, 25C, 26A, 26B, 27A, 27B, Refuge]

The first specimens recorded for Caroline County (USNM 198675) were collected at a wetland site 14 km S Bowling Green (0.8 km N junction of US Rt. 301 and Co. Rt. 601) on 6 March 1974 (Funderburg et al., 1974c). Wood frogs are locally common on the base and appear to occupy a variety of wooded and partially open sites near breeding sites. Larvae have been encountered in vernal pools in road ruts and woodland depressions. Egg laying occurs earlier than any other frog. The earliest known date is 19 February 1997. Recent metamorphs were observed on 4 June 1996 in a road rut pool.

13. *Rana sphenocephala* (Southern leopard frog) - [TA 6B, 28B]

Of the ranid frogs documented for Fort A.P. Hill, this is

the species least often encountered. We have heard them calling on 5 and 14 March 1996 in a small beaver-maintained pond on the western margin near US Rt. 2.

14. *Rana virgatipes* (Carpenter frog) - [TA 2, 3A, 3B, 4B, 5A, 5C, 6B, 7A, 7B, 7C, 9B, 13B, 22A, 23B, 23C, 24A, 24B, 25A, 27A, 14, 30, Refuge; CA 5, 7, 11, 12, 15; Impact site 2]

Of the five areas in Virginia known to support this species (Pague, 1991), Fort A.P. Hill and Caroline County has the largest number of populations. The first observation of this species in Caroline County was a recording of a male vocalization on 13 April 1967 at a location 12.6 km S of the junction of US routes 2 and 301 by Ann Pace (Pace, 1974). Funderburg et al. (1974a) reported specimens from Crump Creek in Hanover County collected on 30 April 1974. Carpenter frogs occur in numerous freshwater wetlands, most of which are naturally acidic beaver ponds with abundant vegetation and deep organic substrate. The first museum specimens collected were found along the Mattaponi River, 9 km S Bowling Green (10 July 1973; USNM 198859) and 13 km S Bowling Green (22 September 1973; USNM 198679) by J.F. Funderburg and his students from Randolph Macon College (Funderburg, 1974). Specimens collected on Fort A.P. Hill have been deposited in the Virginia Museum of Natural History (VMNH 6757).

Seasonal activity dates are 18 April - 19 November. Males vocalize day (sporadically) and night during the breeding season of April-July, although intensity levels and chorus size increase after nightfall. Inclusive calling dates are 18 April - 27 September. Recently metamorphic individuals and tadpoles with rear legs were found on 18 August 1993.

15. *Scaphiopus holbrookii holbrookii* (Eastern spadefoot toad) - [TA 3B, 15B, 21D, 22A]

Two adults were captured while they were crossing Lee Drive, 0.3 km E jct. of A.P. Hill Drive, on the night of 28 March 1994 by Robert Hogan; both were later released. These subterranean frogs seldom appear on the surface except during periods of heavy rainfall. The latest recorded activity date is 4 October 1997.

16. *Ambystoma maculatum* (Spotted salamander) - [TA 1B, 2, 3A, 5A, 5B, 5C, 6A, 6B, 6C, 7A, 7B, 7C, 8A, 8B, 9A, 9B, 10A, 10B, 10C, 11A, 11B, 12A, 12B, 12C, 13A, 14, 15A, 15B, 16B, 18B, 20A, 20B, 20C, 20D, 21A, 21B, 21C, 21D, 22A, 22B, 23A, 23B, 23C, 25A, 25B, 25C, 26A, 26B, 27A, 27B, 28A, 28B, BSA, Refuge]

Spotted salamanders were first reported for this area by Brittle (1969b); 1.6 km NE Pettigrew (1 April 1969; VCU 83). This species also occurs widely on A.P. Hill where it breeds in vernal pools in woodland and grassland depressions, roadside ditches, and road rut pools. Most egg laying sites lack fish predators. Early activity dates for adults are 24 February 1996 and 19 February 1997. Egg laying has been recorded from the third week of February through the second week of March. Aquatic larvae remain in pools until July - September when most metamorphosis occurs.

17. *Ambystoma opacum* (Marbled salamander) - [TA 1B, 3B, 5A, 6B, 7B, 7C, 9B, 10C, 12B, 15A, 15B, 20B, 21D, 22A, 25C, 27B, Refuge]

Although this salamander occurs throughout the base, it appears to be more locally restricted than the spotted salamander. This may be due to their use of fish-free woodland and other vernal pools for reproduction. Adult males and females emerge from fossorial shelters in hardwood forests in periods of September rainfall and migrate to the edges or interiors of pool depressions where they seek retreat under logs. Females have been found with their eggs under logs in mid-September and October. Larvae overwinter in the pools and metamorphose during May and June the following year. Metamorphs have been observed on 18 and 20 June 1997.

18. *Desmognathus fuscus fuscus* (Northern dusky salamander) - [TA 20D, 25B, 26B, BSA; CA 24, 25]

Dusky salamanders were first recorded for the Finnegan Field area of the base with specimens collected on 10-11 July 1963 (KU 158950-55, Collins, 1966). We have found them in seepage habitats and along small streams. Dates of observation include 19 April 1993 (adult), 22 November 1993 (larvae), and 18 April 1997 (adult).

19. *Eurycea cirrigera* (Southern two-lined salamander) - [TA 6B, 17A, 22A, 23A, 24B; CA 23, 24, 25]

This species is often confused with the northern two-lined salamander (*E. bislineata*) because the two are nearly identical morphologically. We based our identification of this salamander on the results of distribution data derived from starch-gel electrophoresis comparisons by Dr. Paul W. Sattler (personal communication) that indicates salamanders south of the Fredericksburg area are *E. cirrigera*. The first specimen of this salamander collected on base was from Finnegan Field on 10-11 July 1963 (KU 158856). Dale Brittle collected one at the junction of US 301 and Mill Creek on 9 November 1969 (VCU 2861). Dates of observation on the base are 25 April to 22 November.

20. *Eurycea guttolineata* (Three-lined salamander) - [TA 5C, 20D, 23A]

Collins (1966) first reported three-lined salamanders from Finnegan Field based on a specimen collected on 10-11 July 1963 (KU 158904). We have observed this species in seepage areas in only three other sites. Our earliest record is of a larva collected on 23 February 1997 at the edge of a beaver pond.

21. *Hemidactylium scutatum* (Four-toed salamander) - [TA 3A, 5C, 21D]

This species has been documented from Fort A.P. Hill with the observation of four specimens in three locations found on 16 and 29 March 1997, 3 April 1996, and 3 April 1997. They occur in seepage areas that usually support sphagnum. It is undoubtedly more widespread than these records indicate.

22. *Notophthalmus viridescens viridescens* (Red-spotted newt) - [TA 1A, 1B, 2, 3A, 3B, 5A, 5C, 6A, 6B, 7A, 7B, 7C, 8A, 9A, 9B, 10B, 11A, 12A, 12B, 12C, 13A, 14, 15B, 16B, 18A, 18B, 18C, 20A, 20B, 20D, 21B, 21D, 22A, 23A, 23B, 25A, 27A, 27B, 28A, 28B, 30, Refuge]

Newts are widespread on Fort A.P. Hill, occurring in beaver ponds, roadside ditches, and vernal pools. Two specimens were collected near Woodford on 20 February 1939 (USNM 127504-05). Adults have been found in aquatic habitats with or without fish in every month of the year. We have observed aquatic larvae in July and August and efts in terrestrial habitats, usually hardwoods, between March and October.

23. *Plethodon cinereus* (Red-backed salamander) - [TA 1A, 1B, 3A, 3B, 5C, 4, 6A, 6B, 7A, 7B, 7C, 8A, 9A, 9B, 10A, 10C, 11A, 11B, 12A, 12B, 13A, 13B, 14, 15A, 15B, 16A, 16B, 18A, 18B, 18C, 20A, 20B, 20C, 20D, 21B, 21D, 22A, 23A, 23B, 25A, 27B, 28A, 28B, Refuge]

This terrestrial salamander occurs in hardwood forest habitats throughout the base. Individuals have been found in upland and riparian habitats and some habitats with a mixture of pine and hardwoods. Most individuals were found under logs and other surface objects in spring and fall months. The first specimen collected on Fort A.P. Hill was from the vicinity of Herns Pond on 20 March 1976 (USNM 203044). Our earliest record is 1 March; the latest is 17 October.

24. *Plethodon cylindraceus* (White-spotted slimy salamander) - [TA 1B, 2, 4, 5C, 6A, 8A, 11A, 12B, 12C, 13A, 13B, 14, 18A, 20A, 20B, 20C, 20D, 21A, 21D, 27A, 28A, Refuge]

Slimy salamanders occur in hardwood forest habitats throughout Fort A.P. Hill. They have been found in and under logs primarily in spring and fall months. Early and late records are 31 March and 19 October 1997, respectively.

25. *Pseudotriton montanus montanus* (Eastern mud salamander) - [BSA]

Mud salamanders have been found in only one location: vicinity of Herns Pond on 20 March 1976 (USNM 203043).

26. *Pseudotriton ruber ruber* (Northern red salamander) - [TA 5C, 6C, 9A, 12C, 13A, 18A, 18C, 24B, 26A, 27A, 30; CA 24]

This species has been found in five locations on Fort A.P. Hill, including a larva found on 22 November 1993, an adult captured during the VHS spring field trip in 1995, and three more found in 1996. The larva was found in a seepage pool. The earliest observation date for an adult is 2 April 1997 and the latest is 29 October 1996.

27. *Siren intermedia intermedia* (Lesser siren) - [TA 3B, 5C, 6B, 24B]

SMR first reported this species from Caroline County as a northern range extension based on specimens collected by minnow trapping in Turkey Track Creek between 29 March and 1 April 1994 (VMNH 6761-6763) (Roble, 1995). Other specimens have been collected 29 March - 17 June from slow-moving streams and beaver ponds.

28. *Siren lacertina* (Greater siren) - [TA 6C, 24B, 30]

The first specimen collected in the vicinity was found on 2 January 1903 at Guiney Station (USNM 31086). The first specimen collected on the base was a dead adult found in Cattlet Creek on 3 April 1992 by N. Van Alstine and K.A. Buhlmann (VMNH 6408). A juvenile was dipnetted and released by KAB later that day at the same location. Additional individuals have been caught in beaver ponds in other Mattaponi River drainages.

Reptiles

29. *Chelydra serpentina serpentina* (Common snapping turtle) - [TA 10B, 12, 16B, 22A, 23A, 23C, 27B, 3A, 6B, 7B, 7C, 9B, 30, Drop Zone, Refuge; CA 21]

This common freshwater turtle is abundant in beaver-

maintained wetlands, marshes, and reservoirs on Fort A.P. Hill and vicinity. Early and late dates of seasonal activity are 4 April and 27 September. A <1 year-old juvenile was observed swimming downstream in Mount Creek on 27 May 1994 and another one was found in a shallow, ephemeral pool in an open, loblolly pine-dominated area on 30 July 1997. Adults have been trapped in several beaver ponds and impoundments. A gravid female was observed on land on 10 June 1997. A clutch of 32 eggs were found exposed in a recently plowed wildlife field on 19 June 1997.

30. *Chrysemys picta picta* (Eastern painted turtle) - [TA 1A, 2, 3B, 5A, 5B, 5C, 6A, 6B, 7A, 7B, 7C, 9B, 10A, 12B, 12C, 13A, 14, 18C, 20B, 20D, 21C, 21D, 22A, 22B, 23A, 23B, 24A, 24B, 26B, 28, 30, BSA, Drop Zone, Refuge; CA 6, 24; Impact sites 1, 2]

Painted turtles have been seen commonly on logs and snags in beaver ponds and reservoirs throughout the base. Seasonal observation dates range from 7 March to 4 October. Trapping results include 16 adults captured in a single hoop trap set overnight on 29 April 1995 at Travis Lake. Several individuals have been marked and released in this location and in ponds in the Drop Zone and TA 21D. A female was observed completing her nest in sandy soil at the edge of a dirt/gravel road on 15 July 1997. The nest contained 5 eggs.

31. *Clemmys guttata* (Spotted turtle) - [TA 10B, 28A]

Only two individuals of this wetland-dependent turtle have been found on Fort A.P. Hill. The first was and adult on 4 April 1996 in a red maple/alder wetland and the second was also an adult on 12 June 1996 in an ephemeral pool in a dirt road.

32. *Kinosternon subrubrum subrubrum* (Eastern mud turtle) - [TA 3B, 8A, 10B, 11B, 12B, 14, 24B, Drop Zone; Impact site 2]

This species may be more common than our records indicate because they tend to be terrestrial for much of their annual activity season (Gibbons, 1983). One record is from a stream, two are from ponds, and six are from roads during terrestrial movements during rain events. Dates of observation range from 4 April to 14 October.

33. *Pseudemys concinna concinna* (River cooter) - [TA 25A]

The dry shell of an adult female was found in mixed hardwood forest near Mill Creek in the Rappahannock River drainage on 29 July 1997. We believe this turtle was on a nesting foray when she was apparently killed by predators over 150 m from the stream.

34. *Pseudemys rubriventris* (Red-bellied turtle) - [TA 3B, 5A, 5C, 6A, 7A, 7B, 10B, 12, 13B, 14, 20B, 20C, 20D, 21A, 21B, 21D, 22A, 22B, 23B, 24B, 25C, 2B, BSA, Drop Zone, Refuge; CA 10, 11, 12, 21; Impact sites 1, 2]

This large basking turtle occurs in all large bodies of water on the base, including beaver ponds, streams, and reservoirs. Observations of seasonal activity based mostly on observation of basking turtles range from 29 March to 14 November. SMR observed a headless adult floating on the surface of the ponded section of Turkey Track Creek at Jeff Davis Drive on 13 September 1993. Several have been marked in Travis Lake, Fishhook Lake, and a beaver pond in TA 21D.

35. *Sternotherus odoratus* (Stinkpot) - [TA 1B, 3B, 4B, 5A, 5C, 7B, 7C, 9A, 21D, 22A, 23A, 23C, 24B, 28, 30, BSA, Drop Zone, Refuge; Impact site 2]

Stinkpots seldom bask and are usually much more common than observational records indicate. Adults have been captured in traps set overnight in all months between April and October. Our earliest record of seasonal activity is 18 April and the latest is 17 September. Shells of dead turtles have been found adjacent to several beaver ponds. A <1 year-old juveniles was captured in a minnow trap at Jordan Crossing Pond on 28 April 1995.

36. *Terrapene carolina carolina* (Eastern box turtle)- [TA 1B, 2, 3A, 3B, 4B, 5A, 6A, 6B, 6C, 7B, 11A, 12A, 12B, 13A, 15A, 15B, 17A, 18B, 18C, 20C, 20D, 21A, 21C, 21D, 24B, 25A, 27B, 30; CA 3, 6, 10]

This terrestrial turtle is encountered commonly throughout the base, especially on roads after wet periods in spring and summer. Dates of activity range from 12 April to 4 October. Nesting behavior was recorded on 23 June 1997; the female was digging in a dirt road. Several shells were found near ponds in the Impact area.

37. *Cnemidophorus sexlineatus sexlineatus* (Six-lined racerunner) - [TA 2, 3B, 5C, 6B, 15A, 15B, 23A, 25A, 25C, 27A, 27B, 28B]

A single specimen from the vicinity of Corbin near the northwestern corner of Fort A.P. Hill was collected on 2 November 1968 (VCU 20). This is the latest date recorded for this species in Virginia (Mitchell, 1994) and may have been uncovered in a hibernation burrow. Open, xeric habitats with sandy substrate are preferred by this lizard. Pockets of such habitat occur throughout the base

and most support small populations. Observations of active individuals span 14 June - 15 August.

38. *Eumeces fasciatus* (Five-lined skink) - [TA 1B, 2, 3B, 5A, 5C, 6B, 7A, 7B, 11B, 14, 16B, 18B, 18C, 20B, 20C, 21D, 22A, 23A, 23B, 24B, 25C, 26A, 28A, 30, BSA, Refuge]

This is the most common skink on Fort A.P. Hill, although based on our surveys, it is nowhere abundant. Most of our observations have been in mixed hardwood forests. Inclusive dates of seasonal activity are 2 April and 25 September. Juveniles from eggs laid in 1997 were observed on 4 August and 25 September.

39. *Eumeces laticeps* (Broad-headed skink) - [no TA]

An adult male was collected 2.7 km NW Port Royal on the south side of US Rt. 17 on 17 April 1977 at 1200 EDT under bark of a standing dead tree in the middle of Goldenvale Creek (USNM 234386). No other individuals have been observed within Fort A.P. Hill boundaries.

40. *Sceloporus undulatus hyacinthinus* (Northern fence lizard) - [TA 2, 3B, 5A, 5B, 6B, 7A, 7B, 7C, 8A, 10B, 11B, 12A, 13A, 14, 15A, 15B, 16C, 18A, 18C, 21D, 22B, 24A, 24B, 25A, 26B, 27B, 28A, 28B, 30, Refuge; CA 23; Impact site 2]

Fence lizards occur widely on Fort A.P. Hill in xeric habitats largely characterized by pine. Adults have been observed as early as 7 April and as late as 1 October. Recently hatched juveniles have been recorded between 18 September and 4 October.

41. *Scincella lateralis* (Ground skink) - [TA 2, 3B, 5A, 5C, 7B, 24A, 25A, 28B, Refuge; CA 15; Impact site 3]

Despite the amount of hardwood habitat on Fort A.P. Hill, this small, leaf litter skink does not appear to be common. We have observed it in only 11 localities. One voucher specimen (VMNH uncatalogued) was obtained during the VHS spring field trip on 29 April 1995. This specimen represents a new Caroline County record (Mitchell, 1994) *fide* Hayslett (1995). Seasonal activity dates recorded are 28 April and 10 September.

42. *Agkistrodon contortrix mokasen* (Northern copperhead) - [TA 1A, 5C, 6B, 20D]

A single individual was collected near Rappahannock Academy on 29 May 1969 (VCU 49). We observed individuals in only four sites despite intensive searches for snakes over at least four years. Copperheads do not appear to be numerous in this area. Nearly all of our records are in June.

43. *Carphophis amoenus amoenus* (Eastern worm snake) - [TA 3A, 3B, 4, 5A, 6B, 7A, 8A, 10A, 11B, 12B, 12C, 13A, 13B, 15B, 16C, 18A, 18B, 18C, 20A, 20B, 20C, 21D, 22A, 25A, 26A, 26B, 27B, 30, BSA, Refuge]

Worm snakes have been found in a number of sites throughout Fort A.P. Hill, most under logs or other surface objects in patches of hardwood forest. Seasonal activity dates are 3 March - 25 September. A single specimen was collected at Rappahannock Academy on 17 October 1968 (VCU 55).

44. *Coluber constrictor constrictor* (Northern black racer) - [TA 1B, 3A, 5A, 5B, 7B, 9B, 12, 14, 18C, 20B, 20C, 20D, 21B, 21C, 22A, 23B, 24B, 25A, 25C, 26A, 26B, 27A, 30, Refuge]

Museum specimens from Bowling Green collected on an unknown date (USNM 45568) and on 25 September 1968 (VCU 23) and from Rappahannock Academy on 21 July 1969 (VCU 45) suggest that this snake occurs widely in the region. Several have been found dead on base roads. Dates of observation span from 26 March to 4 October. Seven eggs were found in a recently plowed wildlife field on 19 June 1997.

45. *Diadophis punctatus edwardsii* (Northern ringneck snake) - [TA 3A, 3B, 5A, 5C, 6A, 8A, 13A, 13B, 14, 18B, 20A, 20C, 25A, 27A, 28B, 30, BSA, Refuge]

This small snake has been captured primarily in hardwood forest habitats in widely scattered locations on the base. The first specimen was collected at Finnegan Field on 10 June 1963 (KU 144753). Seasonal activity records range from 3 April to 13 August.

46. *Elaphe guttata guttata* (Corn snake) - [CA 16]

A single adult was found in Ruther Glen on 23 May 1969 (VCU 40). The only record for the base is an adult found in the northern portion of CA 16 on 28 June 1996 (VMNH uncataloged).

47. *Elaphe obsoleta obsoleta* (Black rat snake) - [TA 1B, 2, 5A, 5B, 6A, 7A, 8A, 13A, 13B, 16C, 18A, 20A, 20D, 22A, 23B, 25A, 25B, 26B, 27B, 30, Refuge; CA 6]

Despite the fact that this is the largest snake on Fort A.P. Hill, it has been recorded from fewer than 10 localities. The first record of this species for the base is one collected near the Wilcox area on 20 June 1965 (KU

144775). Dale Brittle collected one at Port Royal on 2 June 1968 (VCU 46). Seasonal activity dates are 7 April - 4 October.

48. *Farancia erytrogramma erytrogramma* (Rainbow snake) - [TA 3B, 4B, 24B, 25; CA 21]

This is an aquatic snake seldom seen on land but nevertheless occurs in several watersheds on Fort A.P. Hill. The first specimen recorded was a dead adult collected by SMR and C.S. Hobson on 27 September 1993 beside a road bordering Timmons Marsh (CA 21) (Roble & Hobson, 1994; VMNH 6808). Another adult was found in the Impact Area on 28 June 1996. Several others have been captured in minnow traps in ponds and marshy creeks in the Mattaponi River drainage, suggesting that this is not an uncommon species. Most of our records were obtained in June and September.

49. *Heterodon platirhinos* (Eastern hognose snake)- [TA 12B, 18C, 21B, 23A]

The first specimen was collected near the Wilcox area on 24 June 1965 (KU 144917). Another specimen was collected at Alps on 17 September 1968 (VCU 47). Our earliest date of observation was 2 March and the latest is 11 June.

50 *Lampropeltis calligaster rhombomaculata* (Mole kingsnake) - [TA 5A, 22A]

A subadult specimen was found dead on A.P. Hill Drive near the Refuge by DNH personnel on 16 September 1992. Another had been collected in Sparta on 4 May 1967 by Dale Brittle (VCU 22). An adult male was killed by a plow in a wildlife field on 7 July 1997.

51. *Lampropeltis getula getula* (Eastern kingsnake) - [no TA]

No records of this snake are available for Fort A.P. Hill. However, one specimen from Sparta was collected by Dale Brittle on 4 May 1969 (VCU 50).

52. *Nerodia sipedon sipedon* (Northern water snake) - [TA 2, 3B, 4, 5A, 5B, 5C, 6A, 7B, 7C, 9B, 10A, 10B, 13A, 22A, 23A, 24B, 27A, 28A, Refuge]

This semiaquatic species probably occurs in most of the wetlands, ponds, reservoirs, and streams on Fort A.P. Hill. Our records indicate that is occurs widely. It was first collected near the Rodes area on 20 June 1965 (KU 144856). It was also collected at DeJarnett's Pond on 16 August 1973 (VCU 53). Early and late dates of activity are 16 April - 4 October.

53. *Opheodrys aestivus* (Rough green snake) - [TA 1B, 7B, 12A, 25C, Refuge]

The first specimen collected for the area was on 28 September 1968 at Milford (VCU 39). The fewer than 6 sites recorded for this slender snake on Fort A.P. Hill may not reflect its true distribution or abundance. Known seasonal activity dates are 14 May - 17 August but these are based on a small sample.

54. *Regina septemvittata* (Queen snake) - [TA 4, 25B]

The first specimen was collected near the Wilcox area on 25 June 1965 (KU 144877). Two additional adults were caught by minnow traps in a beaver pond in TA 25 on 11 and 17 September 1997.

55. *Storeria dekayi dekayi* (Northern brown snake) - [TA 15B]

A single adult female was found on 15 May 1997 under the bark of a log adjacent to a stream in hardwood forest.

56. *Storeria occipitomaculata occipitomaculata* (Red-bellied snake) - [TA 30]

One adult female was found on 21 May 1997 under a pile of bark in mixed hardwood forest.

57. *Thamnophis sauritus sauritus* (Eastern ribbon snake) - [no TA]

One individual from Caroline County (specific locality unknown) was collected on 10 March 1973 (VCU 41). No specimens have been documented for Fort A.P. Hill.

58. *Thamnophis sirtalis sirtalis* (Northern garter snake) - [TA 5A, 7B, 17A]

An adult was found dead on Early Drive, 0.3 km W junction with Jeff Davis Drive by SMR on 29 April 1995 during the VHS spring field trip. Dale Brittle found a specimen at Sparta on 3 May 1969 (VCU 51). Christopher S. Hobson observed an adult crossing Jeb Stuart Drive on 15 September 1997 in TA 17A.

59. *Virginia valeriae valeriae* (Eastern smooth earth snake) - [TA 12B]

An adult male was found on 26 June 1997 in a 5-10 yr-old

clearcut and an unsexed juvenile was found on 25 September 1997 in a plowed wildlife field.

Potential Species

Several species not yet documented for Fort A.P. Hill occur in or near Caroline County. One or more of these may occur on the base and be verified with additional field research. These include two frogs: *Hyla femoralis* (King and Queen County [Hoffman, 1979, 1988]) and *Pseudacris brimleyi* (Dawn, Caroline County [Hoffman, 1983]), two salamanders: *Amphiuma means* (Hanover County) [Mitchell, 1974] and *Ambystoma tigrinum* (Hanover County) [Funderburg et al., 1974b; Pague & Buhlmann, 1991], one turtle: *Kinosternon baurii* (King and Queen County [Lamb & Lovich, 1990; Mitchell, 1994]), two snakes: *Cemophora coccinea* (King and Queen County, [Mitchell, 1994]), *Lampropeltis triangulum* (Lancaster County [Mitchell, 1994]), and one lizard: *Eumeces inexpectatus* (King and Queen County [Mitchell, 1994]). One of us (JCM) identified a color slide by Dale Brittle taken of an individual found near Bowling Green as potentially being the striped mud turtle (*K. baurii*). Tim Southard (Fort A.P. Hill staff, personal communication) described a snake he had seen on Fort A.P. Hill over 10 years ago that could have been either the scarlet snake (*C. coccinea*) or the banded form of the eastern milk snake (*L. triangulum*).

DISCUSSION

From a regional perspective the herpetofauna of Fort A.P. Hill is diverse and rich. This diversity results from several factors, including being located in the Atlantic Coastal Plain in which several southern species reach their northern range limits (Tobey, 1985; Conant & Collins, 1991; Mitchell, 1994) and the occurrence of a large number of terrestrial and freshwater habitats. The numbers of amphibians (28) and reptiles (31) currently documented for the base and the vicinity in Caroline County are higher than those reported for other studied sites in the region. For example, 22 amphibians and 27 reptiles are known for Fort Belvoir (Ernst et al., 1997), 20 and 25, respectively, for Quantico Marine Corps Base and the adjacent Prince William Forest Park (J.C. Mitchell, unpublished), and 24 and 21, respectively, in the Cohoke Mill Creek area of King William County, Virginia (J.C. Mitchell, W. Van Devender, K.A. Buhlmann, and T.K Stanley, unpublished). Differences in species richness can be attributed to the sizes of the areas noted, their inclusive habitat diversity, and the amount of time these areas have been surveyed by field biologists.

Biological inventories rarely are able to detect the entire flora and fauna of an area unless many years are spent on the effort. Gibbons et al. (1997) stressed the need for long-term sampling to document thoroughly the herpetofauna of a particular area. They noted specifically that cryptic species, like certain snakes, may take years (or even decades) to discover, especially if the survey area is large. They also demonstrated that perceptions of the relative abundance and distribution of some species can change as the area becomes more thoroughly sampled; species thought initially to be rare and local may prove to be more common and widespread. These authors cautioned that land management decisions based on short-term sampling for some faunal groups could have negative implications for those taxa. Observations we present in this report on the herpetofauna of Fort A.P. Hill, a nearly 76,000 acre military reservation, spanned portions of six years. Limited effort was expended in some years and the result is that our report is far from being complete. Many of the results on which this current study is based emphasized amphibians and reptiles associated with wetland habitats, although JCM and associates have spent considerable time in terrestrial habitats. We have used several techniques associated with visual encounter surveys (Heyer et al., 1994), but have not used intensive sampling techniques, such as large drift fences with pitfall traps (Gibbons & Semlitsch, 1982; Mitchell et al., 1993; Enge, 1997). We are currently using automated animal vocalization tape recorders (Peterson & Dorcas, 1994) to assist with JCM's inventory of frogs and toads in selected wetlands and the efforts to catalog the diversity of species among habitats continues with the use of several techniques.

Habitat diversity of places like Fort A.P. Hill did not develop overnight or exist in its current ecological status when the base was first established. The history of the landscape in Caroline County now outlined by the military reservation is one of intensive farming and timber removal. Much of the landscape was undoubtedly in open agricultural fields with scattered patches of forest in different stages of regrowth. The presence of furrows, old road beds, and vegetation and human structures (e.g., wells) observed in many places where forest communities exist today support that interpretation. Wetlands consisted of streams and ponds used for sources of water. Many of the wetlands present on Fort A.P. Hill today owe their existence to the activities of the abundant beaver (*Castor canadensis*) populations. Most of the streams on the base are small and sluggish Coastal Plain tributaries and are impounded in many places by beaver dams. Free-flowing streams are scarce. The presence and continued persistence of large meta-populations of *Rana virgatipes*, a rare to uncommon species elsewhere in the Coastal Plain of Virginia (Mitchell, 1991; Pague, 1991), on Fort A.P. Hill is apparently dependent on the existence of numerous naturally acidic beaver ponds on base. These

same wetlands harbor rich assemblages of dragonflies and damselflies, including many species that are rare or uncommon elsewhere in the state (Roble & Hobson, 1996). Thus, the acquisition of rural agricultural land for the military reservation in Caroline County, Virginia, and the decision to allow most of it to proceed through natural ecological succession created an important conservation area for the central Coastal Plain.

The Department of Defense manages some 25 million acres (10.1 million ha) on more than 425 major military installations, ranking it fifth among federal landholding agencies (Boice, 1997). Many of these lands, like Fort A.P. Hill, have been protected from development and other adverse activities to their natural habitats. These lands support a wealth of biodiversity, including approximately 220 federally listed species. The natural and many of the managed habitats on Fort A.P. Hill harbor a relatively rich herpetofauna, including several species that are uncommon in Virginia and several that are at or near their latitudinal range limits. The ecological changes since its establishment parallel those that occurred at the Savannah River Site (SRS) over much the same time period. SRS was originally used for rural farming but has changed into one of the most important biodiversity conservation areas in southeastern North America with a rich herpetofauna (Gibbons & Semlitsch, 1991). Thus, the concept and management of reclaimed farmland for conservation purposes has had a long history with multiple examples. Descriptions of the flora and fauna of other military bases and federal and state installations from the perspective of how reclaimed farmland has aided conservation efforts would be instructive. Information on the species present, their habitat affinities, and seasonal dynamics among taxa would help managers of these lands to see the value of maintaining as much of the land in natural habitat as possible.

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Distribution of the Atlantic Bottlenose Dolphin (*Tursiops truncatus*) in the Chesapeake Bay Drainage in Virginia

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INTRODUCTION

Coastal and estuarine Atlantic bottlenose dolphins (*Tursiops truncatus*) in Virginia are part of the coastal migratory stock listed as depleted under the Marine Mammal Protection Act (Wang et al., 1994). Live observations, strandings, and behavioral activity of bottlenose dolphins are well documented at the mouth of the Chesapeake Bay and along the southern coastline of Virginia (Blaylock, 1988; Barco, 1995;, however, few data are available on occurrences in mainstem rivers and tributaries of the state. Bottlenose dolphins are known to occur in Virginia from April through November (Barco, 1995) and ascend into tributary rivers of the Chesapeake Bay, but only anecdotal data of bottlenose dolphin occurrences in rivers are available. Historically (pre-1900), bottlenose dolphins were observed 29 km downstream of Washington D.C. in the Potomac River and above the Aqueduct Bridge near Washington D.C. (Paradiso, 1969). More recent anecdotal data in Virginia indicate the presence of bottlenose dolphins in the Rappahannock River at Tappahannock, Cypress Swamp near Smithfield, Elizabeth River at Craney Island, and York River at Gloucester Point. In Florida, bottlenose dolphins are known to occur 120 km upstream in the St Johns River (R. Wells, personal communication, Mote Marine Laboratory) and in the Indian/Banana estuarine system (Odell & Asper, 1990).

In 1995, a marine mammal management plan for Virginia, funded by the Virginia Coastal Program at the Virginia Department of Environmental Quality, was completed by federal and state agencies, members of academia, and conservation organizations. The overall objective of the plan is to protect, manage, and enhance marine mammal populations and promote education, participation, and coordination in Virginia (Terwilliger & Musick, 1995). This study addressed three objectives under the 1995 management plan for marine mammals: (1) to describe the spatial distribution of bottlenose dolphins in the mainstem rivers and tributaries; (2) to establish observation programs; and (3) to improve public participation and interest. Similar comprehensive surveys and long term observation programs were conducted in Georgia and Maryland (Wang et al., 1994).

MATERIALS AND METHODS

Volunteers were recruited to record observations of bottlenose dolphins from May through October 1996 in tidal portions of river mainstems (James, York, Rappahannock, Potomac), mainstem tributaries, peninsula tributaries, and bay and oceanside areas of the Eastern Shore, Virginia. The primary observation group consisted of water quality monitors (WQM) representing the Alliance for the Chesapeake Bay who are responsible for weekly water quality monitoring at fixed locations throughout the Bay region. Topographic maps (1:24,000) were distributed to WQMs to develop ARC INFO/GIS coverages, and observation effort (minutes) was calculated for each WQM. Secondary (i.e. incidental)

observers consisted of volunteers and staff from river organizations, federal and state agencies, military installations, and private entities. These included Dahlgren Installation, Fort Belvoir, Fort Eustis, Mason Neck National Wildlife Refuge, Department of Conservation and Recreation-Division of State Parks, Department of Health-Division of Shellfish Sanitation, Virginia Marine Resources Commission-Law Enforcement, Virginia Institute of Marine Science, American Rover Sailing Vessel, The Bay Institute, Chesapeake Bay Foundation-York River Chapter, Christopher Newport University, Friends of the Elizabeth River, Surfrider Foundation, and Virginia Power. Survey forms were issued to WQM and incidental observers to record date, waterbody, location, dolphin abundance (maximum, minimum, estimate), and water quality parameters (salinity, temperature, tide period). Volunteer workshops were conducted by the Virginia Department of Game and Inland Fisheries, Richmond, Virginia, and the Virginia Marine Science Museum, Virginia Beach, Virginia, to educate participants on the biology and ecology of bottlenose dolphins, and survey protocols. Aerial surveys were conducted along mainstem rivers and peninsulas on 16 August and 20 September 1996 from 0800 to 1800 hours to augment land-based volunteer efforts (Fig. 1). A World Wide Web site (http://www.vims.edu/cbnerr/teach/dolphome.htm) was also developed to capture similar incidental data in 1997 using an electronic data sheet, and to provide long term observations.

RESULTS AND DISCUSSION

Forty-six WQMs and 15 incidental observer groups participated in the survey. One hundred and fifty-seven WQM reports were submitted at the end of the study period, representing a total effort of 63.5 hours. The greatest amount of effort and number of observations were in the Elizabeth (n=10) and Rappahannock (n=10) river systems. Based on the estimated number of individuals per observation, the average number of dolphins in a group was 14. Several small individuals were observed, indicating the presence of calves or subadults. Urbanna Creek, a tributary of the Rappahannock River, was the most upstream observation point of bottlenose dolphins in tidal mainstem river tributaries during the period of observation (Fig. 2). The most upstream point for mainstem river dolphin observation was at Stove Point along the Rappahannock River near Water View, Virginia.

We were unable to generate effort analyses (i.e., number of dolphins observed per hour of observation per area) for the WQM observers because so few observations were recorded (n=3). This may be attributable to the short duration of observation time (<5 minutes) and the fact that many water quality monitoring stations were located outside bottlenose dolphin preferred habitat. We did not ask incidental observers to record effort because many observations were made while observers were participating in other activities (e.g., fishing, sailing, swimming).

Despite difficulties in calculating effort, these data provided the first recorded upper extent movements of bottlenose dolphin in mainstem rivers and tributaries. This information is being disseminated to wildlife managers, federal and state natural resource agencies, local planners, and schools. This study also provided an initial assessment of the effectiveness of volunteer observers to obtain dolphin sightings and determined that volunteers can be utilized in large scale distributional research. However, future studies should incorporate stationary boat-based observation stations where effort and area can be documented and compared among stations. Data generated from this type of study will allow delineation of relative abundance areas.

ACKNOWLEDGMENTS

This project was funded, in part, by the Virginia Coastal Resources Management Program at the Virginia Department of Environmental Quality through grant #NA47OZ0287-01 of the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not reflect the views of NOAA or any of its subagencies. A special thanks to the Virginia Marine Science Museum and the Virginia Department of Game and Inland Fisheries for serving as the coordinating agencies, and to Marcy Judd, Citizen Monitoring Coordinator, Alliance for the Chesapeake Bay, Richmond, Virginia, for coordinating water quality monitor activities. We are also grateful to Zohra S. Haziq, Chesapeake Bay National Estuarine Research Reserve Center, Gloucester Point, Virginia, for the development of the World Wide Web page, Chris Mattson and Greg Harvey, Virginia Department of Game and Inland Fisheries, for map production, and all the observers for their participation.

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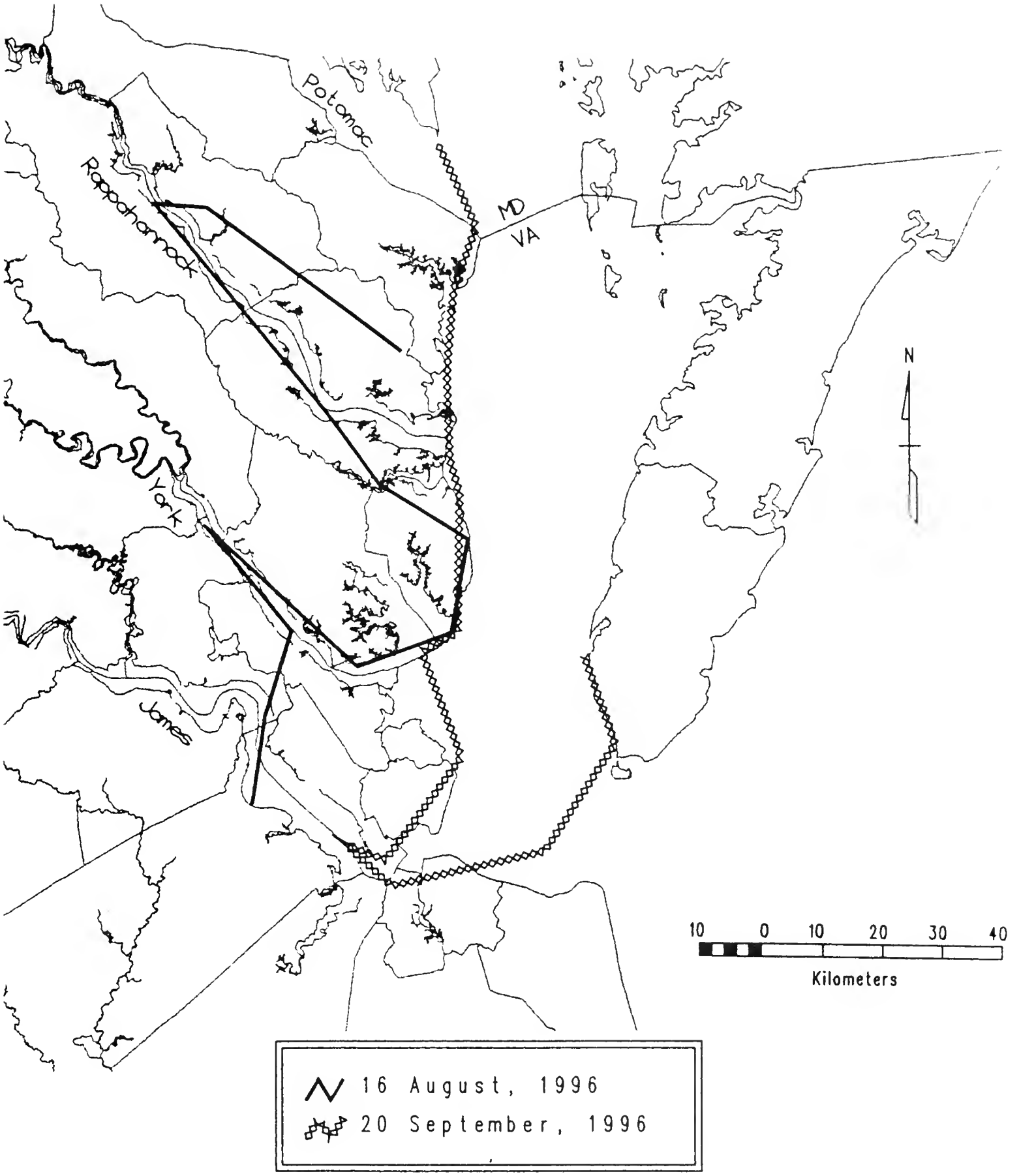

Fig. 1. Flight patterns on 16 August and 20 September 1996 in the Chesapeake Bay drainage in Virginia.

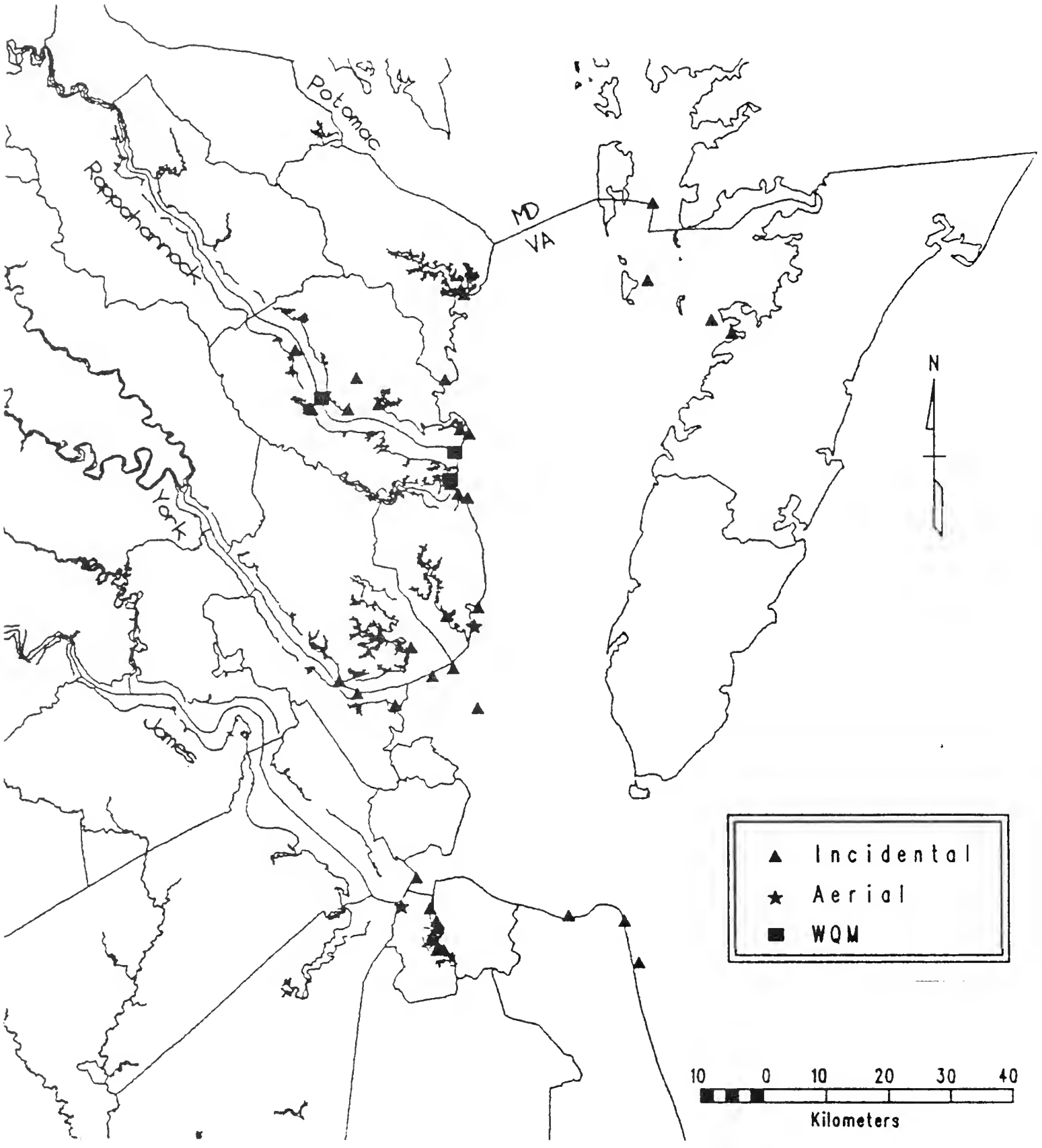

Fig. 2. Dolphin observations from May 1996 - November 1997 in the Chesapeake Bay drainage of Virginia.

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The Virginia Piedmont Water-boatman *Sigara depressa* (Heteroptera: Corixidae) Rediscovered in Virginia

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INTRODUCTION

The family Corixidae (Order Heteroptera) is cosmopolitan in distribution and specimens have been taken from every continent (Bobb, 1974). Commonly called water boatmen, these insects occupy a wide range of aquatic habitats, including pools, ponds, backwaters of streams, and occasionally slow-flowing streams. Most species live in fresh water but a few inhabit brackish waters. Corixids can be found in extreme abundance at some sites, often with several species found in the same habitat.

The Virginia Piedmont water-boatman (*Sigara depressa* Hungerford) is a poorly known member of the family Corixidae. Described by Hungerford (1948) on the basis of material collected in Fluvanna County in 1947 and 1948, it can be distinguished from other local species of *Sigara* by its color pattern and characteristics of the male pala and claspers. Adults overwinter in backwater pools of small streams and become active by March (Bobb, 1974).

This species is apparently endemic to Virginia (Polhemus et al., 1988; Hoffman, 1991). Its historical distribution includes only four sites (Fig. 1), all of which are small streams in Virginia's Piedmont physiographic province (Caroline, Fluvanna, Hanover, and Prince William counties). Bobb (1974) stated that *S. depressa* has not been collected in Virginia since 1948, when he collected only a few specimens at the type locality, even though it was common at the same site during the previous year. His subsequent surveys at this site were unsuccessful. Bobb found this species at only one other locality (Campbell's Creek, Caroline County) despite his fairly intensive surveys for aquatic Heteroptera throughout Virginia. The most recent collections of *S. depressa* were made in 1969 when John T. Polhemus (personal communication) took it on 13 June in Prince William Forest Park (Prince William County) and J. Quensen found it on 3 July at County Route 658 along the North Anna River (Hanover County). One male specimen collected at the Prince William (county) site is currently retained in the J. T. Polhemus Collection, Colorado Entomological Museum, 3115 South York Street, Englewood, CO 80110. One male specimen from the Hanover County site is deposited in the entomology collection at the USNM (D. A. Polhemus, personal communication). Neither of these 1969 collection sites were mentioned by Bobb (1974) or

Hoffman (1991).

In 1997, the Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH) received funding through the Canon Exploration Grants Program of The Nature Conservancy to conduct surveys for *S. depressa* (Fig. 2) in an effort to rediscover this species in Virginia.

MATERIALS AND METHODS

Surveys for *S. depressa* were conducted from July through November 1997 at 27 sites in Caroline, Charlotte, Fluvanna, Halifax, Louisa, Mecklenburg, Orange, and Prince William counties. Fine mesh dip nets and hand collection methods were used at each site. Nets were pulled through overhanging vegetation along the banks and through emergent vegetation and decaying leaves on stream and pond bottoms. Sites included small to medium-sized streams with habitat charac-teristics similar to the original collection sites in Caroline and Fluvanna counties as described by Bobb (1974), and small, permanent and ephemeral ponds in upland and bottomland habitats.

Voucher specimens were preserved in 70% isopropyl alcohol and have been or will be placed in a reputable museum collection. Two specimens collected on 12 September 1997 have been deposited in the collection of the Virginia Museum of Natural History, Martinsville, Virginia.

RESULTS AND DISCUSSION

Specimens thought to be *Sigara depressa* were found at one site near the type locality in Fluvanna County (Fig. 1). Our tentative identification was verified by Dr. Richard L. Hoffman of the Virginia Museum of Natural History. The site is located on Ballinger (at County Route 631), just downstream of its confluence with Hunters Branch, approximately 1.5 km SSE of the type locality (Hunters Branch at U. S. Route 15). Habitat consisted of a quiet, deep (0.75-1.0 m) sand and muck-bottomed pool about 15 m downstream of an extensive series of riffles intermittent with shallow run habitat. Three adults of *S. depressa* were captured during approximately 45 min of intensive dip-net sampling on 12 September 1997. All three specimens were captured in or around overhanging grasses, forbs, and blackberries (*Rubus* spp.) that extended into the water along the west bank of Ballinger Creek at the upstream end of the pool habitat. Surveys at this site after dusk on 18 November 1997 revealed five additional specimens, of which three (2 males, 1 female) were retained as vouchers. Intensive surveys at this site on the following day failed to produce additional specimens.

Sampling at multiple sites within Prince William Forest Park on 17 September and 3 October 1997 did not reveal additional specimens of *S. depressa*. The Hanover County collection (1969) was made only a few years before the creation of the Lake Anna reservoir. This site is currently a few kilometers downstream of the dam, and although it was not revisited by the authors, it likely has been altered since *S. depressa* was collected there. Locality data for the Campbell's Creek site in Caroline County (Bobb, 1974) indicate that it is 20.1 miles (= 32.4 km) north of Ashland at U. S. Route 1. We found no streams named Campbell's Creek in this vicinity on the Ladysmith USGS quadrangle or in the Virginia Atlas and Gazeteer (DeLorme Mapping, 1995). However, our attempts to locate this site revealed that a housing development called Campbell's Creek Estates is located along the South River north of Ladysmith Virginia, approximately 20 miles (= 32.3 km) north of Ashland. Habitat at this site along the South River is similar to that described by Bobb (1974) for the Campbell's Creek site. Our attempts to capture *S. depressa* in the South River at U. S. Route 1 were unsuccessful.

The habitat in which *S. depressa* was found during 1997 is relatively common throughout a large portion of the Piedmont physiographic province in Virginia. Focused searches in similar stream habitats and within ponds might reveal this species at additional sites in Virginia and adjacent states. Hoffman (1991) stated that extensive sampling in the central Virginia Piedmont is needed to ascertain the current biological status of this species prior to the formulation of any protective or management measures.

ACKNOWLEDGMENTS

The authors thank landowners at survey sites in Caroline, Fluvanna, Louisa, and Orange counties for permission to access streams adjacent to their properties. We also thank York Grow at John H. Kerr Reservoir and Dam, U. S. Army Corps of Engineers, and Carol Pollio at Prince William Forest Park for their co-operation in surveys conducted on federal lands under their management. Thanks to Darryl Glover of the Chesapeake Bay Local Assistance Department for his assistance in contacting landowners in Caroline County. Special thanks go to Richard L. Hoffman for verifying the identification of *S. depressa*, and John T. Polhemus, Dan A. Polhemus, and Antti Jansson for their assistance with specimen records for this species.

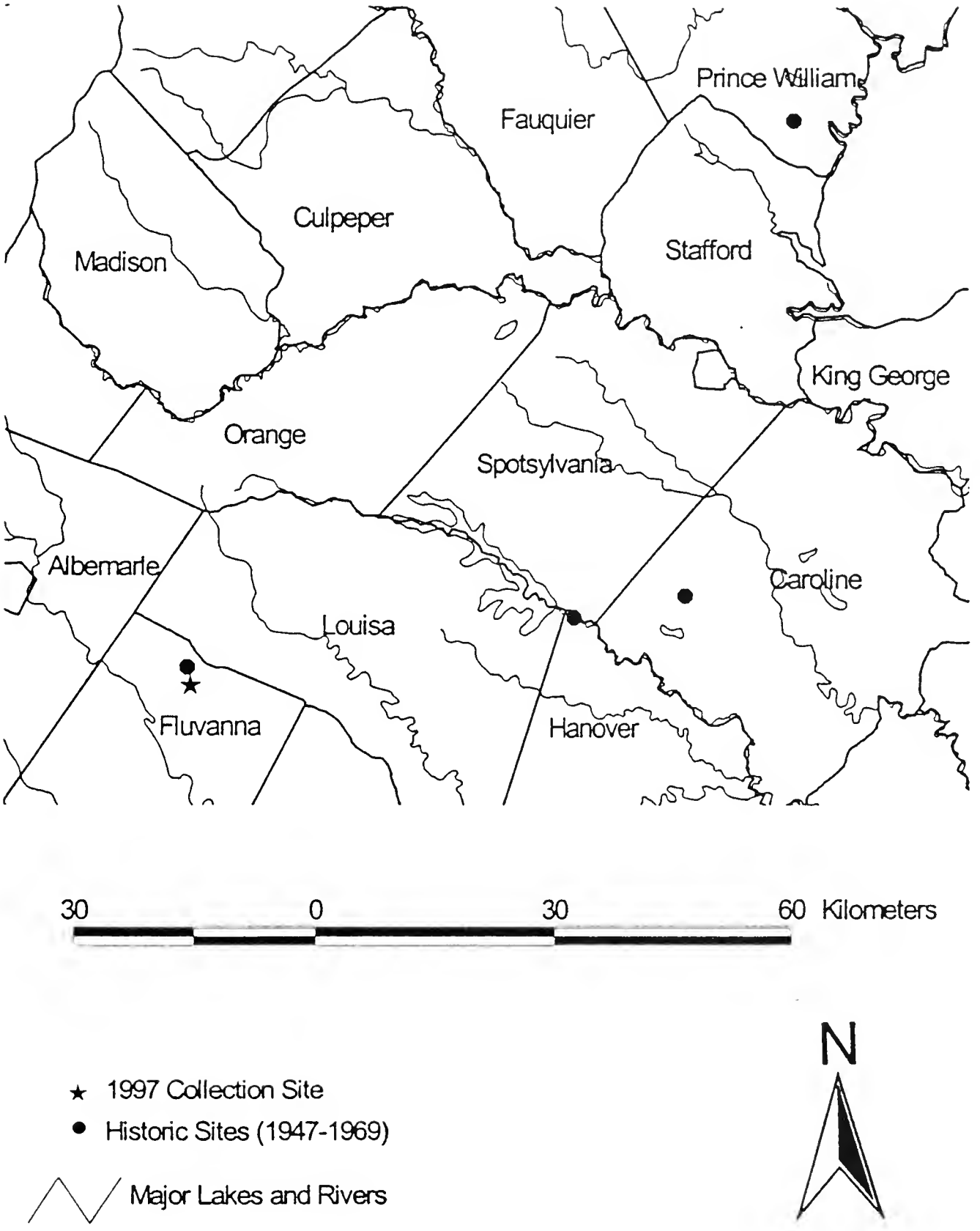

Fig. 1. Known localities for *Sigara depressa* in Virginia; details as in figure subheading.

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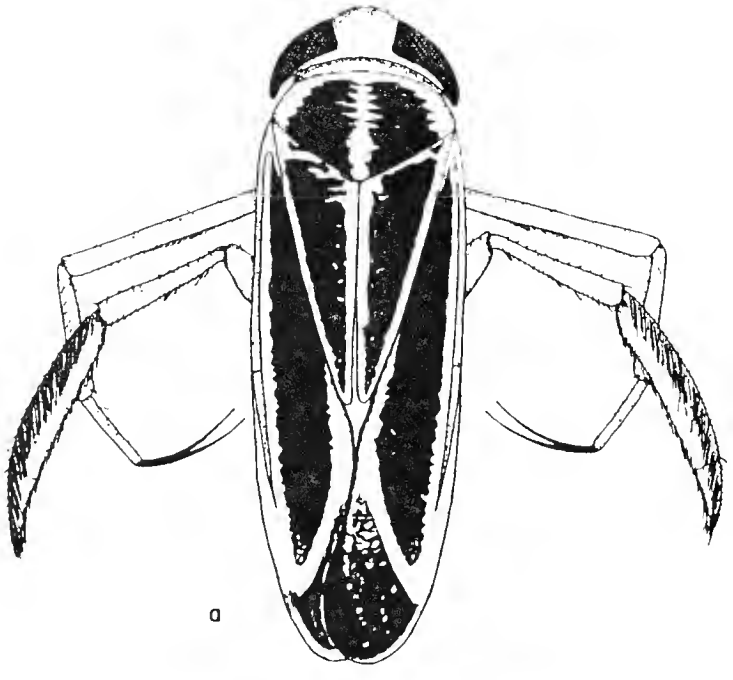

Fig. 2. *Sigara depressa* Hungerford. Dorsal aspect of adult (from Bobb, 1974).

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Notes on the Distribution and Ecology of Some Amphibians and Reptiles in Southeastern Virginia

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INTRODUCTION

Historically, the Great Dismal Swamp covered a large area of approximately 5700 km^2 in southeastern Virginia and northeastern North Carolina (Kearney, 1901; Oaks & Whitehead, 1979). Much of the landscape was composed of saturated forested wetlands and upland swales bisected with rivers and streams. The region was characterized by hardwood-dominated forests that included bald cypress (*Taxodium distichum*), tupelo gum (*Nyssa aquatica*), swamp black gum (*N. sylvatica*), and Atlantic white cedar (*Chamaecyparis thyoides*), before the arrival of Europeans (Whitehead & Oaks, 1979). Removal of forest cover by the colonists and their decendants and construction of deep drainage ditches allowed conversion of much of the landscape to agriculture and, more recently, urban and suburban development (Levy & Walker, 1979). Much of the current landscape not used for agriculture or development supports various stages of ecological succession. Patches of second-growth and later regenerations of hardwood forest remain scattered throughout the region. The present study was conducted in several habitat types that represent much of the current range of variation in natural habitats.

The checklist of amphibians and reptiles native to southeastern Virginia is essentially complete (Tobey, 1985; Mitchell, 1994). However, the microgeographic distribution of these species within the historical Great Dismal Swamp and vicinity is not thoroughly understood (Mitchell et al., in press). This is due, in part, to loss of habitat, especially wetlands, in southeastern Virginia east of the Great Dismal Swamp National Wildlife Refuge. Additional factors include constraints on accessibility to remaining natural areas on public and private property and types of inventory techniques that were used historically by herpetologists in the area (e.g., hand collection, nighttime road-cruising). Known distributions of species and habitat associations of the herpetofauna are based on specimens in museum collections and records in the literature. Information derived from these sources produces gaps in distribution patterns and often provides only anecdotal knowledge of habitat affinities. Thus, although we know which species occur in the area, additional information, especially quantitative data, could be a substantial contribution.

Here we present herpetofaunal results of a pitfall trap study designed to gain information on the distribution of shrews in southeastern Virginia (Erdle & Pagels, 1995). Although amphibians and reptiles were caught incidentally to the original objective, the collections nevertheless provide useful distributional and ecological information. These observations supplement those summarized for the amphibians and reptiles of the historical Great Dismal Swamp by Mitchell et al (in press).

MATERIALS AND METHODS

We sampled 25 sites (Table 1) in the Cities of Chesapeake and Virginia Beach in the eastern portion of historical Great Dismal Swamp and associated wetlands between US Route 17 and Back Bay (see Fig. 1 in Erdle & Pagels, 1995) from mid-June 1990 to late-December 1991. Habitat types ranged from old field to shrub-forest edge to forests of various ages and

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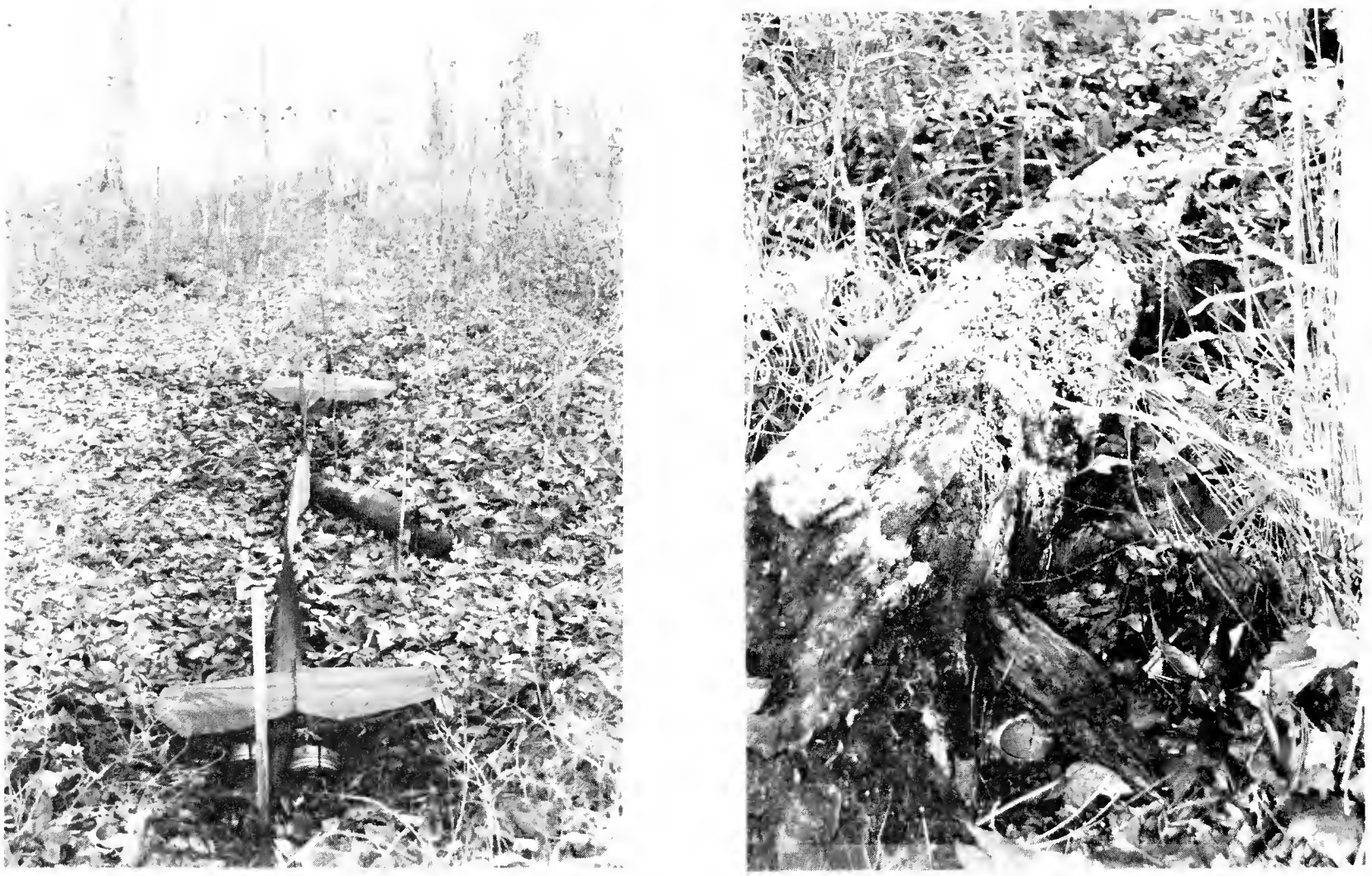

a b

Fig. 1a,b. a, drift fence and 3.8-l pitfall trap array design used to capture small terrestrial vertebrates in southeastern Virginia. b, installed, isolated 0.47-l aluminum can pitfall trap used to capture small terrestrial vertebrates. Photographs by S.Y. Erdle.

composition. Habitats and site locations are described briefly in Erdle & Pagels (1995) and in Table 1. In 13 of the sites (labeled S), a single 5-6 m drift fence made of 30 cm-tall black silt fencing (Enge, 1997) and a pair of 3.8-l (#10 can) pitfall traps were installed in the ground (Fig. 1a). Can openings were sunk flush to the surface of the ground on each side of the ends of the fence. At site S3, two 7.6-l (2 gallon) plastic buckets and 12 single 0.47-l (16 oz) aluminum cans were placed in a variety of locations near the pitfall array. Pitfalls associated with drift fences were shielded with a section of silt fencing constructed to reduce flooding from rainfall (Fig. 1a). In 9 of these sites, four to seven 0.47-l aluminum cans were sunk in selected locations around the area. Number of trap nights ranged from 660 to 2160 for drift fence/pitfall trap arrays and 388 to 3480 for isolated pitfall traps. In another 12 sites (labeled C), 5-11 isolated 3.8-l or 0.47-l aluminum can pitfalls were installed randomly in the substrate (Table 1). Many of the isolated cans were placed adjacent to logs and other surface objects that acted as natural drift fences (Fig. 1b). Number of trap nights in these sites ranged from 1950 to 8174. All pitfalls were half-filled with dilute formalin to facilitate drowning and specimen preservation. Traps were checked approximately bi-monthly and specimens were stored in 50% isopropyl alcohol. All specimens were subsequently identified to species in the laboratory. Snout-to-vent length (SVL) of selected individuals were measured with a plastic ruler to the nearest millimeter. Specimens were deposited in the Virginia Museum of Natural History Herpetological Collection.

RESULTS

A total of 879 specimens of 10 species of amphibians (7 frogs, 3 salamanders) and 7 species of reptiles (2 turtles, 4 lizards, 1 snake) was caught in the 25 sites sampled. Eight species of frogs, 2 salamanders, 1 turtle, 3 lizards, and 1 snake were caught in the drift fence/pitfall arrays alone or with associated can arrays. Four frogs, 2

salamanders, 1 turtle, and 1 lizard were caught in the single can pitfall grids. Species distributions among the 25 sites varied from a single specimen at one site to numerous specimens in 17 sites.

Annotated Species List

1. *Bufo terrestris* (Southern toad) [Sites: C1, C3, C4, C12, S1, S1A, S3, S5, S6, S7, S8, S9, S10, S11, S12]

Of 70 specimens caught, 9 (12.9%) were adults, 58 (82.9%) were juveniles, and 3 (4.2%) were recent metamorphs. Captures of adult males (6) nearly equaled those of females (5). Over half of the juveniles (57%) were caught in June-August 1990. Recently transformed metamorphs were caught during periods of 1-13 August 1990 (11 mm SVL), 10 May-2 June 1991 (9 mm SVL), and 23 August-20 September 1991 (11 mm SVL).

2. *Gastrophryne carolinensis* (Narrow-mouthed toad) [Sites: C2, C3, C4, C6, C9, C11, C12, S1, S3, S4, S5, S6, S8, S9, S10, S11, S12]

A total of 102 individuals was captured (47% adults, 53% juveniles). No metamorphs were caught. Adults and juveniles were captured in all months of the sampling period, except for December 1990 to mid-March 1991. Most juveniles (34 of 54) were captured during September - November 1991. The smallest individual was a recent metamorph at 8 mm SVL caught 26 October - 9 November 1990, and the largest was a female at 30 mm SVL.

3. *Hyla chrysoscelis* (Cope's gray treefrog) [S7]

A single juvenile was captured during the period of 4-30 January 1991.

4. *Pseudacris crucifer crucifer* (Northern spring peeper) [S3, S4, S5, S7, S12]

Six adults (2 males, 4 females) and 1 juvenile were captured in 5 sites. One recently metamorphic individual (10 mm SVL) was captured during 10-28 May 1991

5. *Pseudacris brimleyi* (Brimley's chorus frog) [S1, S1A, S4]

Two single, adult females were captured during 17-26 October 1990 and 26 October - 9 November 1990.

6. *Rana clamitans melanota* (Green Frog) [C1, C7, S2, S4, S5, S7, S10, S11]
Of the 129 individuals caught in the pitfall traps, most (83%) were juveniles. The largest number of captures (55 of 107) occurred in mid-June - August 1990. Other captures occurred in all other months through August 1991. Only 1 adult female was captured. Recent metamorphs were captured primarily in June - August in both years; one was caught in the 14 November - 5 December trapping period and 2 in September-November 1991. Eighteen metamorphs averaged 31.7±2.1 mm SVL (28-35).

7. *Rana sphenocephala* (Southern leopard frog) [C1, C5, C12, S1, S1A, S4, S5, S7, S8, S10, S11]

This species comprised the majority of all captures in this study (54% of 879). Only 7 adults were captured. Number of juveniles (230) captured was similar to the number of recently metamorphosed frogs (237). Most of these (195 and 226, respectively) were captured in June - August of both sampling years. A sample of 75 metamorphs averaged 27.8±2.3 mm SVL (22-33).

8. *Ambystoma opacum* (Marbled salamander) [S7, S10, S11]

Six adults (3 males, 3 females) were captured in these 3 sites. The dorsal pattern phenotype of 2 males and 2 females was the typical series of light crossbars. One male had a parallel stripe pattern and one female had 2 crossbars in addition to parallel stripes. A single metamorphic individual was captured during 10-28 May 1991.

9. *Plethodon cinereus* (Red-backed salamander) [C1, C3, C5, C6, C12, S3, S6, S7, S11, S12]

Of the total sample of 43 individuals, 37 were adults and 6 were juveniles. Fourteen of these exhibited the red-back phenotype and 29 the lead-back phenotype. Two adult salamanders had partially regenerated tails. Most specimens were caught in fall and spring, and a few were captured in January 1991.

10. *Plethodon chlorobryonis* (Atlantic coast slimy salamander) [C3, C6, C9, C12, S1, S4, S7, S8, S11, S12]

Fourteen individuals were captured during this 2-year study: 4 adult males, 4 adult females, and 6 juveniles. One adult had a partially regenerated tail. Only one juvenile was captured in summer (15 July - 2 August); all other individuals were captured in fall, winter, and spring months.

11. *Terrapene carolina carolina* (Eastern box turtle) [C12]

A single juvenile was captured at this site during 2-22 August 1991.

12. *Kinosternon subrubrum subrubrum* (Eastern mud turtle) [S2]

A single adult male was captured at this site during 22 August - 21 September 1991.

13. *Enmeces fasciatus* (Five-lined skink) [C2, C6, S1, S6, S7, S12]

Ten of the 14 individuals captured in both years were juveniles, one was an adult male, and 5 were adult females. Tails of most of the specimens were broken during capture or during handling, but all of those with unbroken tails were complete.

14. *Enmeces inexpectatus* (Southeastern five-lined skink) [S5]

A single 46 mm SVL juvenile was captured during 26 April - 10 May 1991 at this site.

15. *Enmeces laticeps* (Broad-headed skink) [S12]

One juvenile female (63 mm SVL) was captured during 6-26 April 1991 at this site.

16. *Scincella lateralis* (Ground skink) [C2, C6, C12, S2, S3, S5, S11]

Twelve specimens were captured during this 2-year study. Eight were adults and 4 were juveniles. All juveniles had complete tails, whereas 6 of the adults exhibited partially regenerated tails.

17. *Carphophis amoenus amoenus* (Eastern worm snake) [S10]

A single adult male was captured at this site during 5-21 September 1990.

DISCUSSION

Drift fence/pitfall arrays are effective inventory methodologies for selected terrestrial amphibians and reptiles in saturated forested wetlands and associated lowland habitats if used across seasons and herpetofaunal activity periods (Mitchell et al., 1993). However, size of the pitfall trap influences directly the species and sizes of individuals caught. The fewer species and numbers of individuals caught by the small 16 oz. cans compared to the larger pitfalls in this study demonstrate that pitfall size strongly affects catchability and can bias samples toward smaller species and small individuals of larger species. Comparatively, amphibian species richness (5-11) and total numbers of individuals captured (44-702) were larger in a 6-month study in southeastern Virginia using large drift fences and 19 l (5-gal.) pitfalls (Buhlmann et al., 1993). As with this study, *Bufo terrestris*, *Rana clamitans*, and *Rana sphenocephala* dominated the frog samples and two species of *Plethodon* dominated the salamander samples. Species of larger size (e.g., bullfrogs [*Rana catesbeiana*]) and more adults were captured with the larger pitfall traps than the small pitfalls used in our study.

Although amphibian and reptile species richness of the historical Great Dismal Swamp in southeastern Virginia is well known (Tobey, 1985; Conant & Collins, 1991; Mitchell, 1994; Mitchell et al., in press), microgeographic distribution patterns and the ecology of these species remains to be fully elucidated. Results of this study provide no significant geographic distribution records but they do extend our knowledge of the habitat affinities for most of the 17 species we recorded.

The landscape of southeastern Virginia has been altered severely by agricultural processes and urban and suburban development (Levy & Walker, 1979). Increased demands of an ever growing human population for more urbanization of the landscape suggests that there will be less and less habitat in the future for all but the species with the broadest habitat affinities. Because many of the habitats sampled in this study were disturbed by human activities, at least some of the species encountered will probably persist as long as there are wetland breeding sites and patches of upland habitat for shelter. This list includes species such as *Bufo terrestris*, *Rana clamitans*, and *Rana sphenocephala*. *Enmeces fasciatus* and *E. inexpectatus* may persist because they are able to inhabit some human-made structures. Species like *Plethodon cinereus*, *P. chlorobryonis*, *Scincella lateralis*, and *Terrapene carolina* that inhabit the increasingly isolated patches of upland forest will continue to decline because of the loss of such habitat islands. In addition, species that move overland during seasonal movements and migration also face high rates of mortality from increasing vehicular traffic in the area (Mitchell et al., in press). The long-term projection for the status of the herpetofauna in the historical Great Dismal Swamp of southeastern Virginia is that there will be continued decline in number of populations and additional reduction of the ranges of native species. Because the ecology and life histories of many species are not well understood, all information possible on the natural history and ecology of amphibians and reptiles of the area, including the most common ones (Dodd & Franz, 1993), should be amassed and published before the opportunity is lost

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Table 1. Location and habitat type of the 25 study sites in southeastern Virginia. Abbreviations: dfp = drift fence/pitfall array, cans = single can pitfalls.

Site	Trap type	City	Coordinates (Lat/Long)	Habitat
S1	dfp/7 cans	VA Beach	36°47'35'' / 76°04'20''	mature hardwood swamp forest
S1A	dfp	VA Beach	36°43'14'' / 76°02'40''	pine/hardwood forest
S2	dfp/4 cans	Chesapeake	36°43'30'' / 76°16'37''	marsh/mature forest edge
S3	dfp/5 cans	Chesapeake	36°39'40'' / 76°19'45''	shrubby, old field
S4	dfp	Chesapeake	36°39'13'' / 76°22'08''	mixed hardwood swamp forest
S5	dfp/4 cans	Chesapeake	36°34'15'' / 76°20'25''	old field/mature forest edge
S6	dfp/4 cans	Chesapeake	36°38'25'' / 76°20'30''	young mixed forest
S7	dfp	Chesapeake	36°36'05'' / 76°14'50''	mature hardwood swamp forest
S8	dfp/7 cans	Chesapeake	36°36'55'' / 76°11'53''	mature hardwood swamp forest
S9	dfp	Chesapeake	36°34'30'' / 76°14'00''	young mixed forest/field edge
S10	dfp/4 cans	Chesapeake	36°34'05'' / 76°11'55''	young mixed forest
S11	dfp/4 cans	Chesapeake	36°34'40'' / 76°09'05''	mature mixed swamp forest
S12	dfp/6 cans	Chesapeake	36°34'30'' / 76°07'55''	mature hardwood swamp forest
C1	11 cans	VA Beach	36°41'45'' / 76°03'55''	yng pine forest/powerline edge
C2	5 cans	VA Beach	36°34'50'' / 76°05'55''	young mixed forest/swamp edge
C3	6 cans	VA Beach	36°37'05'' / 76°07'15''	young mixed forest/field edge
C4	10 cans	Chesapeake	36°40'38'' / 76°08'45''	young mixed forest/field edge
C5	8 cans	Chesapeake	36°36'55'' / 76°16'40''	mature hardwood swamp forest
C6	9 cans	Chesapeake	36°38'40'' / 76°17'45''	young pine forest
C7	10 cans	VA Beach	36 36'46'' / 76°05'02''	mature mixed swamp forest edge
C8	4 cans	Chesapeake	36°40'26'' / 76°09'25''	young forest/shrub field edge
C9	6 cans	VA Beach	36°45'40'' / 76°02'20''	young mixed forest
C10	10 cans	Chesapeake	36°38'15'' / 76°11'57''	weedy, shrub field edge
C11	10 cans	Chesapeake	36°40'35'' / 76°13'40''	young forest/field edge
C12	61 cans	Chesapeake	36°43'14'' / 76°02'40''	mature mixed forest, young mixed forest, shrub/young forest edge, shrub field edge

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Observations on Nesting by a Fence Lizard, *Sceloporus undulatus hyacinthinus*, in Virginia

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The northern fence lizard (*Sceloporus undulatus hyacinthinus*) is common and widespread in Virginia (Mitchell, 1994). However, few observations of nesting by this species have been made in the state. Apparently the only published report of natural nesting in Virginia is that of de Rageot (1964), who observed a female lay three eggs on 5 June in a small burrow that she had excavated at the base of an oak tree in Surry County; this lizard laid seven more eggs in captivity. Mitchell (1994) reported that egg laying by captive females from Virginia occurred between 23 June and 9 July; 23 clutches contained 6-13 eggs. Palmer and Braswell (1995) reported nesting as early as 12 May in North Carolina, with clutch sizes of 3-16. Nesting habitats and substrates documented in that state include old sawdust piles, old stumps, sandy red clay, coarse sand, road banks and open fields; nest cavity depths ranged from 5-15 cm (Brown, 1992; Palmer & Braswell, 1995). Martof et al. (1980) stated that females in the region may produce a second clutch in an extended season; they also mentioned nesting in burrows under rotten logs. Oviposition usually occurs in May and June in West Virginia (Green & Pauley, 1987). Missouri females lay their first clutches in late May and early June, with second clutches being produced in July (Johnson, 1987).

At 1420 h on 2 May 1997, we encountered a female fence lizard engaged in nesting behavior along FS 609 in the George Washington & Jefferson National Forest, several hundred meters off Co. Rt. 616 in Alleghany County, Virginia. We made the following observations during the next 95 min. A cool, light rain was falling during this entire period, with a brief span of heavier rain near the beginning; ambient temperature was approximately 15-17^{o} C. In an attempt to minimize disturbance, we did not capture the lizard or excavate the nest cavity, although several photographs (without flash) were obtained during the latter portion of the observation period.

The nest cavity was dug in a shaley roadbank, about 1.5 m above the level of the dirt road; it was approximately 5 cm high, 10 cm wide and at least 15 cm deep (Fig. 1). A partial excavation about 1 m lower on the roadbank apparently had been abandoned earlier. While laying eggs, the lizard's tail was pressed up against the rear of the cavity, its chin was down and the back arched; the body undulated from side to side as each egg was laid. Although an accurate count of the number of eggs laid was not made, we estimated a clutch size of 8-10.

Several times during the nesting process, an unidentified muscoid fly (probably Muscidae or Sarcophagidae) landed near the lizard, prompting it to gape and make several unsuccessful capture attempts. At 1454 h the fly landed beside the lizard again and entered the nest cavity, never to emerge. The lizard ate several small ants that passed by the cavity entrance during our observation period.

Oviposition was completed at or shortly before 1505 h, at which time the lizard emerged from the nest cavity and began filling it with shale fragments. While facing toward the road, she used her front legs to pull the fragments up toward the nest (Fig. 2), and then turned 180 degrees to push them into the cavity with her snout and forelegs (Fig. 3). She continued in this manner for 10 min, adding a single upward sweep with the right hind leg while facing the nest. This was followed by an 8 min rest period, then 10+ min of additional filling, using the same behavior including a single hind leg sweep. The fly was buried during the first filling bout. The lizard continued her nest-filling behavior, interspersed with periods of rest, until our departure at 1555 h. By this time the cavity was approximately 90% covered.

Our observations indicate that some fence lizards in Virginia lay their eggs much earlier than reported by Mitchell (1994). In contrast to the female that we observed, which did not initiate nest-filling behavior until her entire clutch had been laid, Johnson (1987) reported that the 15 eggs he excavated from a Missouri nest were deposited in five layers containing three eggs each, with each layer covered by a small amount of dirt. His observations imply that the female partially filled her nest after each group of three eggs was laid.

Fig. 1. Female fence lizard at entrance of nest cavity; one egg is visible to her left.

Fig. 2. Female fence lizard using left foreleg to pull shale fragments up toward nest cavity.

Fig. 3. Female fence lizard using right fore leg to push shale fragments into nest cavity.

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Shorter Contributions

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AN INLAND RECORD FOR THE TIGER BEETLE *CICINDELA TRIFASCIATA ASCENDENS* IN VIRGINIA

– The tiger beetle *Cicindela trifasciata ascendens* LeConte has been recorded infrequently from Virginia. Most Virginia specimens have been found in coastal areas in association with mud flats, small wet depressions in dune habitats, or tidal marshes. This species, although suspected to breed at one or more sites, has not been verified to breed in the state. Knisley & Schultz (1997) show only one record outside of the Coastal Plain in Virginia. The species occurs at other inland sites in Texas, Arkansas, Oklahoma, Kansas, Tennessee, Mississippi, Louisiana, South Carolina, North Carolina, and Georgia (Knisley & Schultz, 1997; Pearson et al., 1997).

In 1997, the Virginia Department of Conservation and Recreation, Division of Natural Heritage began a multi-disciplinary inventory of John H. Kerr Reservoir and Dam, and associated properties in the southern Piedmont physiographic province of Virginia (Mecklenburg, Halifax, and Charlotte counties). These lands are owned and managed by the U. S. Army Corps of Engineers (USACOE). As part of this inventory, tiger beetles (Cicindelidae) were targeted for surveys.

Several species of tiger beetles were captured during 1997 surveys, including *Cicindela punctulata* Olivier, *C. repanda* Dejean, *C. rufiventris* Dejean, and *C. sexguttata* Fabricius. Also, *Cicindela splendida* Hentz, a rare species in Virginia (Roble, 1996), was found by Dr. Steven M. Roble in a powerline just north of the Difficult Creek drainage and outside of USACOE property in Halifax County (new county record). Perhaps the most interesting discovery during these surveys was *Cicindela trifasciata ascendens*. Two individuals were documented at one site on two dates (17 June, 1 July) in 1997. Knisley & Schultz (1997) show this site as the only inland record for *C. t. ascendens* in Virginia, but do not provide details on the collection site or circumstances leading to this discovery. Additional information on the capture of *C. t. ascendens* at Kerr Reservoir is provided herein.

Both individuals of *C. t. ascendens* were found in open habitat consisting of a disturbed powerline right-of-way crossing Butcher Creek adjacent to County Route 688. Apparently, this area has been used as a primitive boat launch in the past, which in conjunction with fluctuating water levels and right-of-way maintenance, has contributed to the openness of the ground adjacent to Butcher Creek where the specimens were captured.

The water levels at Kerr Reservoir fluctuate greatly over the course of a year, and during low levels there are extensive mud flats at many sites. The changing water levels at the capture site for *C. t. ascendens* essentially mimic those seen in tidal marshes where this species has been found previously in Virginia. Although the cycle of high and low water levels at Kerr Reservoir is typically not seen during the course of a single day as it would be in tidal situations, the habitat conditions occurring between the high and low water marks are similar to those seen in coastal estuarine systems. Knisley & Schultz

(1997) state that this species occurs in a wide variety of water-edge habitats, especially mudflats along coastal areas, inlets, tidal estuaries, marshes, and bays.

Only two individuals were observed on two visits to the Kerr Reservoir site, and it is not known if the species breeds there or if the two captures represent vagrants. The habitat in which the specimens were collected is relatively common in the watershed associated with Kerr Reservoir, and additional surveys are planned to determine if a breeding population exists in the area. The two individuals captured in 1997 might be part of a larger population at some yet unknown location in the vicinity. Surveys in 1998 will focus on adult *C. trifasciata ascendens*, and if this tiger beetle is found, searches for larval burrows and larvae will be conducted.

Acknowledgments

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RECENT NOTEWORTHY RECORDS OF THE SWAMPFISH (*CHOLOGASTER CORNUTA*) FROM THE NOTTOWAY RIVER SYSTEM, VIRGINIA – The monumental treatise by Jenkins & Burkhead (1994) on the freshwater fish fauna of Virginia contains an enormous number of distributional records. These authors reported that most records of the swampfish (*Chologaster cornuta*), one of the most unique species found in the state, are from the Blackwater River or the Dismal Swamp area, with isolated records from the Chickahominy River and Seashore State Park (see also Mitchell et al., 1997).

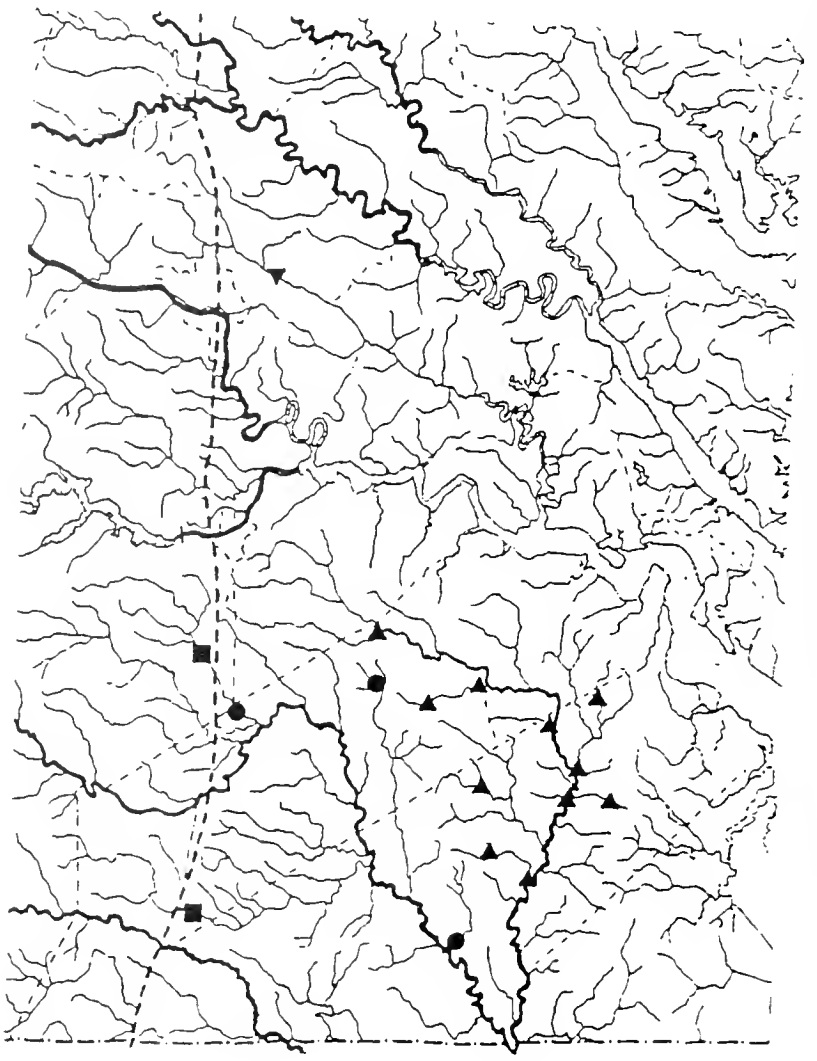

Fig. 1. Distribution of *Chologaster cornuta* in the Nottoway (circles), Blackwater (triangles) and Chickahominy (inverted triangle) rivers in Virginia (redrawn after Jenkins & Burkhead, 1994); records for the Dismal Swamp region and Seashore State Park are not plotted. New localities reported in this paper are shown as squares. Heavy dashed line indicates the Fall Line; following new county lighter dashed lines are county boundaries

Their range map shows only three records from the Nottoway River system, including one in the upper reaches of Assamoosick Swamp (a tributary), quite distant from the mainstem. Based on the scarcity of records, Jenkins & Burkhead (1994) concluded that *C. cornuta* is rare in the Nottoway, a drainage that has been relatively thoroughly sampled for fish. Therefore, we believe the records for the swampfish obtained incidental to very limited sampling for aquatic salamanders in the Nottoway River drainage are noteworthy. All specimens were captured using dip nets and will be deposited in the state fish collection at the Virginia Institute of Marine Science.

Greensville-Sussex County line: Three Creek at County Route 611, ca. 7 km ENE Emporia. 2 September 1992. S. M. Roble. 1 specimen. **Dinwiddie County**: Rowanty Creek at County Route 703, ca. 5 km NW Carson. 12 April 1996. D. J. Stevenson and C. S. Hobson. 2 specimens.

Both of our sites are blackwater streams on the Fall Line, and extend the known range of *C. cornuta* in Virginia slightly inland (Fig. 1). The inlandmost record for this species plotted by Jenkins & Burkhead (1994) is in Sussex County, and is based on a specimen (Cornell University 16884) collected at the Route 301 site on Rowanty Creek that was discussed by Stinson (1997). The latter author determined that the original collection locality was recorded erroneously and that this site is actually 4.8 km S Carson (rather than Reams Station, Dinwiddie Co.). Our collection site on Rowanty Creek is approximately 8 km farther upstream. The Three Creek site is the first record of *C. cornuta* from a tributary south of the Nottoway River and becomes the southwesternmost known locality in Virginia. This site is geographically much closer to the Meherrin River than it is to the Nottoway River mainstem. However, there are no records for *C. cornuta* from the Meherrin River (or Fontaine Creek) in Virginia (Jenkins & Burkhead, 1994), although this species inhabits this portion of the Chowan River drainage in North Carolina (Cooper & Rohde, 1978; Menhinick, 1991).

Acknowledgments

The Union Camp Corporation kindly allowed access to the Three Creek site.

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ELLISON A. SMYTH, JR. (1863-1941), FOUNDER OF THE DEPARTMENT OF BIOLOGY AT VIRGINIA TECH – In 1863, the Civil War battles of Vicksburg and Gettysburg brought the South its first major defeats, Congress created the National Academy of Sciences, and a boy who was to play an important role in Virginia's natural history was born to a prominent family in Charleston, South Carolina. General Sherman's northern army destroyed everything in its path as they marched from Tennessee to the coast in 1864. Elements of that army descended upon Charleston and destroyed many homes and their contents, including that of John E. Holbrook, the father of North American herpetology (Adler, 1979). Sherman's soldiers slashed some of the Smyth family portraits and apparently stole the majority of their set of John James Audubon's elephant folio illustrations from their home in Charleston. The family had moved to their summer home in Summerton to avoid the war. It was there that Ellison Adger Smyth, Jr. (26 October 1863 - 19 August 1941, Fig. 1) was born.

Fig. 1 Ellison Adger Smyth, Jr. Photograph taken at Virginia Tech circa 1920 by an unknown photographer.

Apparently, not all of the Smyth library was destroyed since Ellison Smyth's interest in natural history was stimulated after the tumultuous year of 1864 by his grandfather, who read wildlife books to him. Perhaps this library was allowed to remain at least partially intact by the rampaging soldiers because it was located in a pastor's house. Such inspiration led Ellison to an early interest in natural history. At a young age, probably in his early teens, Smyth was sailing his boat among the barrier islands, particularly Edisto Island, off the South Carolina coast, where he collected insects, eggs, plants, and shells. At the age of 15, he composed a very detailed folder illustrating butterflies and moths of the Carolina coast. The compulsion to collect natural history objects often starts with interests developed in early childhood or early teenage years. People like Ellison Smyth, Jr. have made substantial contributions to the natural history of Virginia.

Smyth entered Princeton University at age 16 in 1879. His collecting instincts taking hold, he climbed a tree in front of the President's house to get an egg from a nest for his collection. To get the egg down safely, Smyth put it in his mouth and slid down the trunk, right in front of President McCosh. When asked what he was doing up the tree, the young Smyth had to take the egg out of his mouth, whereupon the President gave him a lecture on the evils of robbing birds' nests, a lecture he soon forgot. Smyth graduated from Princeton with an AB degree in 1884 and an AM degree in 1887.

His family wanted him to enter his uncle's law firm, so after receiving his undergraduate degree he undertook studies in law at Columbia University. Later, during the summer of 1887, he completed additional studies in law at the University of Virginia. His uncle sent him to Birmingham, Alabama, to tract land titles. He soon became bored with that work and took a position as adjunct professor in the biology department at the University of South Carolina during 1889-1891. The College of New Jersey awarded Smyth an honorary MS degree

in November 1890. In 1891, the Virginia General Assembly appointed John M. McBryde as President of the then Virginia Agricultural and Mechanical College (later Virginia Polytechnic Institute [VPI]) and charged him to reorganize the poverty-stricken, floundering, land-grant institution in Blacksburg. In 1891, McBryde brought in four professors from South Carolina, all of whom were called "rice eaters" by the native faculty. Smyth headed the Department of Biology and became the Dean of the Faculty during 1902-1906. He spent the rest of his career as head of the biology department and retired from it in 1925. While at VPI he received an honorary LLD degree from the University of Alabama in 1906.

Smyth had been an active field biologist in South Carolina. While there he wrote at least two papers on butterflies and produced several short notes on local birds in *The Proceedings of the Elliott Society*, a local natural history society. Upon arriving at Blacksburg, Smyth inherited a small insect collection started at the college in 1888. He continued building this collection and collections of stuffed birds, eggs, and other natural history objects. In 1904, he decided to move his own collection of 1,500 bird skins and 25,000-30,000 insects (mostly Lepidoptera) from the overcrowded Science Hall to his home. This move proved to be fortuitous, as the Science Hall, including Smyth's birds' egg collection, was completely destroyed by fire in 1905 (Smyth, 1993). Most of the insects and birds were donated subsequently to the Smithsonian Institution. Several cases of butterflies, an example of which is in Fig. 2, remain in the entomology collection of the Virginia Tech branch of the Virginia Museum of Natural History. It is clear from Figure 2 that Smyth was meticulous at pinning and labeling insects and creating valuable research collections.

Ellison Smyth specialized in entomology and ornithology during most of his career and dabbled in other disciplines. He was a member of the American Association for the Advancement of Science, the American Ornithologist's Union, and the New York Entomological Society, and was a founding member of the American Entomological Society (Marquis, 1911). He produced several publications on insects, including a description of a new butterfly from Mexico. We know that he helped produce at least three Virginia Tech agricultural bulletins on birds and plants for the public (Smyth, 1892, 1894, 1897). Smyth published the first accurate annotated checklist of birds for Montgomery County in 1912. Two publications stand out from the others. In 1908,

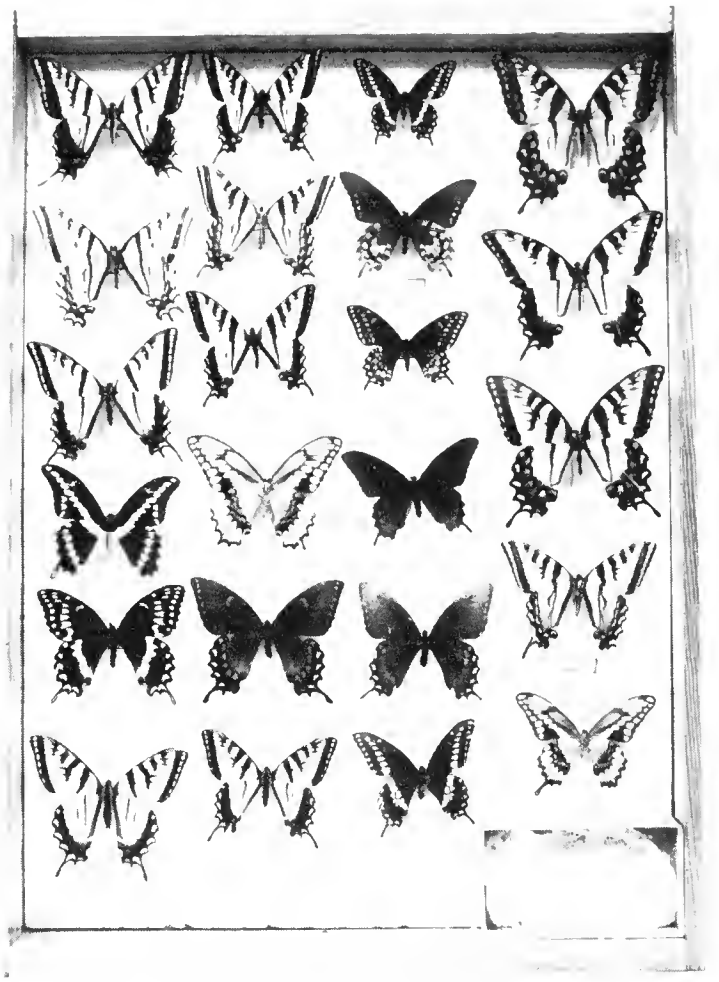

Fig. 2. Photograph of an insect drawer in the Virginia Tech branch of the Virginia Museum of Natural History containing butterflies collected during 1892-1925 from eastern North America and mounted by E. A. Smyth, Jr. Photo by the Virginia Tech branch staff of the Virginia Museum of Natural History.

Smyth described the histology of an ovary from a spayed female puppy, and in 1910 he sought to make entomological sense of a gold-colored bug in a short story by Edgar Allen Poe, the "Gold Bug." He left four unpublished partial manuscripts: color phases of *Agrynnis diana* (1 pg.), butterflies and moths (21 pgs.), birds of the campus (Va. Tech) May 1926 (2 pgs.), and "The 'Cabbage Snake' Scare" (1 pg.), all of which are in the Virginia Tech archives.

Smyth married Grace C. Allan of Charleston, SC, in December 1897. They had two daughters and three sons. The oldest son, Thomas, became a professor of biology at Pennsylvania State University, and the second, Ellison, after working as an electrical engineer, became a Presbyterian minister. He married a botanist. Another son, James Adger, became an ichthyologist, a daughter, Grace, was a trained

sculptress and artist, and another daughter, Amey, was a writer. A nearly 6-inch notebook in the Virginia Tech archives with clippings dating to 1874 suggests that Ellison Smyth, Jr. was a meticulous collector of news items, poems, and funny stories.

Smyth provided a variety of services to students, colleagues, and institutions during his tenure at Virginia Tech. He was an advisor to the US Department of Agriculture's Division of Ornithology and the Smithsonian Institution. He organized and coached Virginia Tech's first football and gymnastic teams

As the founder of the Department of Biology, Smyth offered eight courses: advanced physiology and histology, economic zoology, human physiology, structural botany, structural zoology, systematic botany, systematic zoology, and vegetable physiology and biology. He later (1905) taught the entomology course, first offered in the Horticulture, Entomology, and Mycology section of the Agriculture Department under M.B. Alwood. The budget for the department during this time was $150 to $200. Smyth was instrumental in bringing modern biology to Virginia Tech, as he emphasized theoretical underpinnings of practical biology. In 1918, additional staff were brought on board: W.J. Schoene, the first state entomologist, to teach entomology, and A.B. Massey, after whom the herbarium was named, to teach plant pathology. By 1921 a total of 15 courses were offered, although there was still no undergraduate degree program; the courses were part of the agriculture and applied sciences curricula At Smyth's retirement in 1925, there were 1200 students at Virginia Tech, compared to 135 in 1891, and a degree program was initiated. The department later split along the lines of botany and zoology.

There are nine boxes from Smyth's estate in the Virginia Tech archives. One contains daily observation notes written between 1911 and 1927 on birds and butterflies. Another is filled with sketch books on invertebrate anatomy, negatives and photographs of butterflies, and a catalog of his private Lepidoptera collection. He collected, purchased, and traded many butterfly and moth specimens and made duplicates available to other collectors for sale, as was customary at the time. For example, he had two printed price lists, "Price-list of Lepidoptera offered for sale by Ellison A. Smyth, Jr. VPI, Blacksburg, Virginia" and "Additional list of Butterflies." His prices varied from $0.05 to $1.00 each and differed for male and female specimens, with the former being more expensive because they are usually more colorful and rare. All species on the first list were from tropical countries and were apparently traded or purchased in bulk unmounted. Some of his listed tropical giant and more colorful butterflies would sell from $10 to $50 each today or would not be sold at all, as some are now listed as endangered species. The second list includes European, North American, and tropical species, some in lots of 100 specimens.

Ellison A. Smyth, Jr. is recognized for his dedication to Virginia Tech and natural history by having an academic building named in his honor (Smyth Hall), now housing the Department of Crop and Soil Environmental Sciences (the old Agronomy department), the soil testing laboratory, a copy center, the Office of Institutional Research and Planning Analysis, and a large classroom. A bust in the university branch of the Virginia Museum of Natural History commemorates Smyth's contributions to the Commonwealth through his collections and publications. The original plaster cast for the bronze bust was prepared in 1934 by his daughter Grace.

Ellison A. Smyth, Jr., with his keen field observations and meticulous record keeping, provided much useful information on native and migrating birds and butterflies in South Carolina and Virginia. A new generation of well-trained naturalists and agriculturists resulted from his modern course offerings in life sciences at Virginia Tech. His national reputation as a well-recognized naturalist of his times and his numerous publications brought the work on the natural history of Virginia into international focus.

Acknowledgments

We thank Dr. David A. West, Professor Emeritus of Virginia Tech's Department of Biology, for providing us with some of his written history of the department, on which we depended heavily. We are especially grateful to Ruth Smyth Brown, Dr. Smyth's grandaughter of Bowling Green, Kentucky, for reading a draft of this biography and for providing valuable contributions. The Special Collections staff of Newman Library at Virginia Tech graciously assisted Kosztarab with archival material. Footnote: Ellison A. Smyth, son of E.A. Smyth, Jr., died at age 94 on 9 March 1998.

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Miscellanea

Book Reviews

Mark Catesby's Natural History of America by Henrietta McBurney. 1997. Merrell Holberton Publishers, London. 160 pages. $36.00 hardcover. $19.95 softcover. Video: *The Colonial Naturalist, The Life and Work of Mark Catesby*. 1964. Colonial Williamsburg Foundation. $19.95.

Just before Christmas 1997, my wife and I visited the DeWitt Wallace Gallery in Colonial Williamsburg to view an exhibition of original watercolors by Mark Catesby (1682-1749). Catesby produced volumes on various aspects of the natural history of North America between 1731 and 1747 entitled The Natural History of Carolina, Florida, and the Bahama Islands. The resulting two volume set, plus appendix, contained 263 original watercolors executed largely by Catesby himself by the process of copper etching. The 52 originals from the complete set on exhibition in the United States are owned by Windsor Castle, London, England. It was the first time these originals were loaned to museums anywhere. The above titled book was written primarily to highlight the exhibition and provide historical background and visual references. It is available in hardback and paperback. I found the hardback version in a commercial bookstore in Richmond; paperbacks are available at the gallery and Colonial Williamsburg Visitor's Center bookstore. In addition to the book, a 55 minute video depicting Catesby's life and experiences in America is available in Colonial Williamsburg. The following review covers the exhibition, the book, and the video.

The size of the exhibition was smaller than I expected. However, what was lacking in size was accounted for by the exquisite paintings and watercolor etchings made over 250 years ago. Most of the watercolors were mounted on the walls but several were in Plexiglas cases, including several copies of complete, original volumes opened to a particular page. The lighting provided for each illustration enhanced the artistry of the subjects and provided something of a subdued but scholarly atmosphere. Drawings and paintings by several other contemporary artists were also included. I recall being impressed over several color illustrations of tropical insects by a late 18th century artist. These paintings were produced mostly by copper etching, a painstaking process that required lots of trial and error to get the colors right. And right they are. The watercolors have not faded over all these years. These are among the best examples of natural history watercolors of that era. I doubt, however, that most people who wandered through this section of the

gallery really knew the value and scientific importance of the watercolors hanging on the walls. One had to know something about Mark Catesby and the history of natural history in North America to really appreciate what they were viewing.

The accompanying book is 9.5 x 12 inches in size and beautifully bound. It contains a chapter by Amy Myers on Catesby's biography and how he made the watercolors and assembled the two primary volumes. Catesby did not work entirely on his own, as we learn that he sought help from a professional artist and collaborated with many of his colleagues to produce the first set of natural history illustrations from the North American continent. Henrietta McBurney describes the structure and contents of the two volume original set from the Royal Library that were purchased in 1768 by King George III. The 52 watercolors are arranged under a Catalogue in seven sections: I Birds, II Fishes, III Crabs, turtles, and corals, IV Snakes, lizards, and frogs, V Mammals, VI Insects, and VII Plants. Each plate is accompanied by a detailed description of how it was made and text about the organisms illustrated. Identifications using modern taxonomy are included and clarified where necessary. The colors of the printed are close to the originals, indicating that the book's editor ensured accuracy. This book is an excellent introduction to the science and artistry of *Mark Catesby's Natural History*.

The color video was produced by the Colonial Williamsburg Foundation along with other films about the role of this city in the history of America. The video starts with Catesby's arrival in 1712 and continues through his departure to England in 1719. Catesby's character narrates some of the video, especially in scenes of plants and animals. Most of the actual dialog is between Catesby and William Byrd, two other landowners, and his sister. Much of the footage in Williamsburg depicts Catesby as something of a comical eccentric captivated by local plants and animals and their behavior. Some of the video, too much of it by today's standards, contains footage of various local species without narr-ation. Plants, many birds, several mammals (including the curiosity of the time, the opossum), reptiles (two snakes, three turtles), a bullfrog, and several invertebrates are highlighted. Little actual history of the time is discussed. One obvious error of interest to readers of this journal is the location of John Banister's death noted by William Byrd: "in the Peaks of Otter." This point of information may have been the accepted fact at that time the video was made, since it was before the masterful biography of John Banister by John and Nesta Ewan (1970). The actual location is on the shore of the present-day Banister River in Halifax County. Most of the scenes are of Catesby's stay in Williamsburg, as there is no more than a couple of minutes devoted to the period following his completion of the two books in England. The video is modestly entertaining and would be of interest to people interested in Virginia's natural history. It is not a complete review of the life of Mark Catesby.

The history of natural history in Virginia is a rich, scholarly, and entertaining subject. We are fortunate that there is so much material available on Mark Catesby, who spent seven years exploring the Commonwealth. The recent exhibition of his original watercolors in Williamsburg spawned a new book, resurrected a video, and created additional interest in the man and his contributions to natural history in Virginia (e.g., Badger, 1997). Anyone interested in the history of natural history or Virginia's history would find the book and video to be valuable additions to their library.

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Seashore Chronicles: Three Centuries of the Virginia Barrier Islands by B.M. Barnes and B.R. Truitt. 1997. University Press of Virginia, Charlottesville. 248 pp. $24.95.

The barrier islands that lie along the lower Eastern Shore of Virginia have had a long history of human exploitation and occupation. This book chronicles some of the writings about these islands over the period from 1650 to the present. The chronology is like a sandwich of views: the first writings depict these islands from a wild nature perspective, followed by narratives and stories about the people and domestic animals that settled there, and ending with the exodus of people and the protection of the native flora, fauna, and the natural processes that make the islands what they are. Barnes and Truitt contribute to the content of the book only in a short history of the islands, brief introductions to each chapter, and a set of notes and references. There is an insert of 20 black and white photographs, all of which depict humans and their constructions (houses and boats). Several other

photographs of human-related scenes occur throughout the book. Only one shows a natural scene (foraging terns, pp. 182-183). A map in the front matter illustrates the Eastern Shore and the islands.

The meat of the book consists of 22 passages, letters, and published articles written by 21 authors (2 by Howard Pyle). The first passages tells of victims of a shipwreck in 1650 that had to endure extreme weather and cannibalism. The eastern wolf is mentioned in this one. We learn that sheep and cattle were introduced in the early 1800s to graze freely on the natural grasses on Smith Island. Robert E. Lee, a second lieutenant at the time, visited Smith Island in the spring of 1832 and described in a letter to his father some aspects of its ecology, as well as the large number of ticks he brought back. The wild horses of Chincoteague and Assateague figure prominently in two sections. Shipwrecks, life-saving crews, the towns on Cobb and Hog islands, hurricanes and northeasters, the shorebird and waterfowl hunting, and the fishing figure prominently in many stories. The writing is highly variable, as one might expect in such a collection of works taken from over 300 years of style. I found the most exciting and poignant reading in a passage from a journalist about the life-saving crew and a young local man who saved passengers from a wrecked ship off Cobb Island in 1894. A similar piece of masterful writing was the selection by the ornithologist O.S. Pettingill, Jr. who honeymooned on Cobb Island just before the famous August Storm of 1933 that completely overwashed the island and caused the death of George Cobb, the last inhabitant. The last two chapters cover the period leading up the acquisition of many of the islands by The Nature Conservancy and the establishment of the Virginia Coast Reserve

There is much natural history in these passages but one has to hunt for it. The fact that Assateague and Chincoteague were completely overwashed with sea water in 1821 and Cobb Island in 1933 made me wonder whether populations of the terrestrial amphibians, reptiles, small mammals, and invertebrates were extirpated at that time. Did they recolonize the islands or were some able to survive and produce the decendants that now occur there? Of personal interest, I learned on page 88 how diamondback terrapins were collected and prepared for dinner in 1878. However, I was appalled at the immense slaughter of the shorebirds and their eggs for food and feathers that took place for many decades.

Unfortunately, readers will have to hunt for the information on their group of interest in this book by reading or scanning every page. The index, which should lead us to appropriate passages about natural flora and fauna, is dismally lacking in natural history entries. There are only a few entries like "mosquitoes" and "ticks" under "insects" and "oysters" under "fishing." There is not one entry for the common or scientific name of any species or even the more encompassing groups like waterfowl and turtles. Thus, the book's organization renders it far less useful than it could have been for people interested in natural history.

In other respects, the hardback version of the book is well constructed and attractive. The font size is reasonable; even I can read it well with my low-powered glasses. Left and right-hand margins remain consistent throughout but the top and especially bottom margins vary substantially. Lower margins vary from a half inch to over an inch from the bottom of the page.

I found this book to be useful for additional background on the nature of the barrier islands, insights into how their human inhabitants have altered their landscapes, and a glimpse of the forces of nature that shapetheir physical structure. We are all fortunate that these jewels in the basket of biological wealth contained within Virginia are now protected for the long term by The Nature Conservancy. Read this book for the history and dynamics of these incredible places. Curtis Badger summed it up for many of us who have visited wild places such as these: "The most important discoveries we make are those not found in field guides and scientific literature. Like belief in the supernatural, the islands force us to use our imagination to see beyond the horizon, to see beyond the barrier of years to a world that once existed here and that someday will return."

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Obituary

William S. Woolcott

William Starnold (Bill) Woolcott, Jr. (14 April 1922-18 April 1998) was professor emeritus of biology at the University of Richmond. He was on the faculty of UR from 1955 until his retirement in 1992. Bill was from Tennessee, served in the US Navy in World War II, and graduated with a degree in biology from Austin Peay State University in 1947.

He earned a master's degree in 1948 from George Peabody College, now part of Vanderbilt University, and then taught for four years at Carson-Newman College in Jefferson City, Tennessee. He obtained his Ph.D. from Cornell University in 1955 where he worked under the renowned ichthyologist Edward Raney. At UR, Bill specialized in ichthyology and taught graduate seminars and courses in vertebrate natural history, vertebrate

morphology, general biology, and a variety of related subjects. He was awarded the distinguished educator award by the University and the endowed Kuyk Chair in 1980. He coordinated the graduate program in biology for many years and indeed kept the graduate program alive when there were efforts to abolish it. Bill died of complications derived from a long fight with cardiovascular problems starting with an aneurysm in the mid-1970s.

Bill amassed a large collection of freshwater fishes, most of which were from central Virginia, that was housed at UR until his retirement. The collection is now part of the Virginia Institute of Marine Science fish collection in Gloucester Point. Bill's primary interest was systematics and morphology of fishes. Most of his post-graduate work was with students. Eugene Maurakis worked with him in the 1970s when Bill and others obtained National Science Foundation and Virginia Power funding to study the fishes of the James River. Gene worked with Bill off and on for several years and most recently they collaborated on several projects. These include several papers on the systematics of fishes of the southeast and a professional 25-minute video entitled Phylogenetic Systematics now used by several museums and universities around the world. Of his 60 or so papers, most dealt with fishes, and most were based on populations and collections from Virginia. He published one paper on reproduction in scarlet snakes and two with me, one on red-backed salamander ecology and another on brown water snake reproduction. The latter was based on a thesis by David White directed by Bill and me. Bill was most at home directing research for graduate and senior undergraduate students.

Bill was a member of the American Society of Ichthyologists and Herpetologists, the Society of American Zoologists, the Virginia Academy of Science, and the Association of Southeastern Biologists. He participated actively in the latter two societies where he would insist that his students present the results of their research.

Bill Woolcott is survived by his wife of nearly 50 years, Betty, two daughters, and two grandsons. His legacy will continue in the students he taught that have gone on to become academic biologists and professionals in other areas of science.

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Correction

In *Banisteria* Number 10, the last sentence of the first paragraph of the article by Stinson (1997:28) on *Orconectes virginiensis* should read: "But after searching various maps, other printed references, and communicating with several individuals, I became convinced that the type locality of *O. virginiensis* as described by Hobbs does not exist and that a revision of the type locality of this species is in order."

Reports

1. Report of the Secretary/Treasurer

The following members of the executive committee were in attendance for the 24 January meeting at Hampden-Sydney College, Hampden-Sydney, VA: Michael Kosztarob, Anne Lund, Richard Neves, Richard Hoffman, Steve Roble, Norm Fashing, and Joe Mitchell. (Barry Knisely was unable to attend.) The meeting was presided over by Richard Neves.

Funds on hand at the meeting date were $4,795.85.
Business items adressed:
1. Suggestions were discussed for improving membership. Roble and Mitchell would look into the idea of a brochure to advertise the Society.
2. Shenandoah Valley Sinkhole Pond Symposium was announced as scheduled for September. There was a discussion of special issue of *Banisteria*.
3. There was a discussion of changing the cover of *Banisteria*. Black and white photos will be considered.
4. Page charges were discussed if an author is not a member. Ten dollars a page if author is not a member or one author has to be a member for no charge. Non-member will receive a copy of the journal.
5. Replacing Vice President of the Society was discussed. Neves was to contact possible candidates.
6. Continuing as section of Virginia Academy of Science was discussed.
7. Web page was considered.
8. Hoffman proposed a questionnaire for the next issue of *Banisteria*, concerning such issues as separating from VAS and field trips for the Society.

Respectfully submitted,
Anne Lund
Secretary/Treasurer

2. Report of the President

I assumed the position of President this year upon the

resignation of Tom Rawinski, who departed Virginia for a more lucrative job in Massachusetts. My goal is to continue the progress and initiatives begun by my predecessors and to implement a few of my own. Our Board Meeting in January was fruitful, so let me highlight some of the discussions. The Society continues to have trouble recruiting new members, and we seek a target membership of perhaps 200 within the next 2 years. Each of us has colleagues who are not members; therefore, we need to be proactive recruiters. Most biologists in state agencies are not members, and we need to bring as many of them as possible into the fold. To achieve this target, a new brochure on VNHS is being prepared by Steve Roble as a recruitment tool. Many members attend various scientific and professional meetings in Virginia and adjoining states, and it would behoove all of us to take brochures and solicit interest in the society. Another tool for recruitment and recognition that I am pursuing is a home page. I have contacted a web site specialist and, for a nominal fee, such a site could be on line in a short order. We could begin small and add to it, to include images of native plants and animals.

Another topic that I would like current members to consider is the submittal of manuscripts to *Banisteria*. Most of us in academia are surrounded by unpublished data, our own and those of graduate students, that are germane to Virginia's natural history. This information is soon lost and forgotten in the binders of final reports and theses, and yet part of the record of natural history for that time period. I strongly urge all members to consider submittal of a manuscript within the next year, so that we can diversify the natural history topics in Banisteria and increase the quantity and quality of papers available to our readership. Please consider putting some of this important `dungeon data` into print as a permanent, referenced record of your labors.

A final topic under deliberation is the prospect of an annual meeting of VNHS, separate from the one convened at the Virginia Academy of Science. With our membership hovering at about 150 paying members, it may be premature, in my opinion, to expect adequate attendance at such a meeting. However, with additional and improved camaraderie, such a meeting should be successful. A polling of the membership is planned to get your views on this topic.

The members of the Executive Committee earnestly seek your support to improve the size and effectiveness of our society. We must gain recognition for the society, but of higher priority, for the importance of the natural history enjoyed by all Virginians. I am reminded of the declaration in Ecclesiastes 3:19, "for there is no superiority of the man over the beast, for everything is vanity." Without an educated public with land ethic values, the biota and ecosystems of Virginia will face a solemn future in modern society.

Richard J. Neves
President, VNHS

3. Report of the Editors

Banisteria number 11 marks several changes in the journal. We have decided to retire the front cover original John Banister illustration after 10 issues and will begin using photographs and other pen-and-ink illustrations pertinent to the contents of the respective issue. Frankly, we agonized over this point for 2 years. Were there enough additional illustrations available to warrant this change?

We had placed requests with several colleagues for line drawings, but none were forthcoming. Despite the lack of response from our members, we have decided to take the plunge and will use whatever we have that will work on the front cover. In this issue, we use one of the black-and- white photographs in the lead article. Thus, we plead with members to submit photographs or drawings with their articles so that we can select an illustration that reflects something inside. Or simply send us something for our consideration.

The use of certain kinds of references in the text and literature cited sections of manuscripts has been controversial. The so-called "gray" literature (mostly unpublished reports) has been cited by several authors in their papers. Many journals do not allow such citations because they are often impossible to locate and a copy obtained. We have allowed reports to be used as citations if they are part of a numbered series produced by a public agency (state, federal, or local), that is, they have a technical report number or something similar. Differences of opinion occur among the VMNH executive committee and indeed between the co-editors as to the use of such citations. This topic was discussed at the winter meeting of the executive committee and the results are that gray literature (reports to agencies) will be allowed in papers in Banisteria.

Authors should make sure, however, that such gray literature (technical reports) are filed and policies are established in such a way as to make them available to any reader seeking a copy. Technical reports or documents provided to private companies or non-governmental organizations will not be allowed unless a compelling case can be made that demonstrates that the document is in fact available to the general public.

Members of VNHS noted that issue number 10 of *Banisteria* was thinner than several recent issues and substantially thinner than this issue. This resulted solely from one source: lack of submissions of manuscripts by authors. *Banisteria* is produced twice a year. Manuscripts

need to be in hand (received, reviewed, and revised) by March 1 and October 1 annually. We have not adhered rigidly to this schedule for the simple reason that we have not had the manuscripts ready to go by that time. We urge potential authors to provide manuscripts on a timely basis, and indeed, encourage any author with a story to tell about Virginia's natural history to submit manuscripts. We cannot survive without you.

A change in the production staff of *Banisteria* may be noted. Numbers 5 through 10 were formatted on his home computer by Carl Hoffman, to whom the Society is greatly indebted for the many hours (most of them wee-small) that he vounteered on our behalf. Carl is now being relieved of that often onerous task, with the most sincere thanks of the editorial staff. Beginning with No. 11, *Banisteria* will be formatted by Christine Plauger, an employee of VDGIF stationed in the Department of Recent Invertebrates, VMNH. Being able to perform this work in close proximity to a copying machine will greatly enhance production and eliminate a lot of time and miles formerly spent on the road between Martinsville and Blacksburg. We welcome Tina to the editorial family and feel that the continued quality of our journal is a testament to her abilities.

Finally, we wish to thank the following people for reviewing one or more manuscripts for *Banisteria* issues 1-10: K.A. Buhlmann, J.A. Cranford, S.Q. Croy, C.D. Dondale, C.H. Ernst, J. Ewan, O.S. Flint, W.J. Hayden, M. Hicks, C.S. Hobson, R.L. Hoffman, R.E. Jenkins, K.B. Knisley, D.S. Lee, M. Lipscomb, A.C. Lund, W.H. Martin III, R.W. Miller, J.C. Mitchell, J.A. Musick, J.F. Pagels, T.K. Pauley, T.J. Rawinski, S.M. Roble, R.M. Shelly, D.M. Ware, S.A. Ware, A.G. Wheeler, Jr., T.F. Wiebolt, W.Wieland, and the late W.S. Woolcott.

Announcements

1. New Small Grant Program for Botanists

Small grants for floristic work in Virginia are available through the Barbara J. Harvill Fund. These funds are available to botanists who do not have an institutional base of support for such work. Most awards are mileage costs (within Virginia) for field work with the potential for generating new plant distribution records for the state.

Mileage costs for visits to herbaria, lodging costs, and costs of some types of field equipment (e.g., plant presses) may also be wholly or partially covered. These funds are awarded by the Atlas of the Virginia Flora Committee, Alton M. Harvill, Chairman.

Send a letter of application describing the planned research and its projected costs to Donna M. Ware, Department of Biology, College of William and Mary, Williamsburg, VA 23187

2. Forthcoming Symposium

The George Washington and Jefferson National Forest (now combined administratively) and the VNNH are hosting a one-day symposium on the history, physical environment, and natural history of the Big Levels sinkhole pond area and the Saint Mary's River watershed of Augusta County. These areas are rich in human and natural history and has been the target of numerous biotic and physical environment investigations. The sinkhole ponds are well known for their northern and Coastal Plain disjunct populations and for several unique species. The St. Mary's River is famous for its effects of acid precipitation and loss of biological diversity. The date is currently planned for Friday, September 25, 1998. The location will be the VA Department of Forestry and VA Division of Mineral Resources building in Charlottesville. Plans include the pub-lication of the papers given at this symposium in a special issue of *Banisteria*.

For additional information, contact Joseph C. Mitchell (804-740-7086, jmitchel@richmond.edu), Dr. Dan Downey, Dept. of Chemistry, James Madison University, Harrisonburg, VA 22807 (540-568-6635, downeydm @jmu.edu), or Dawn Kirk, George Washington & Jefferson National Forest, Glenwood Ranger District, P.O. Box 10, Natural Bridge, VA 24579-0010 (540-291-2188, Kirk_Dawn/r8_gwjeff_glenwood @fs.fed.us) .

3. New Natural History Biographies section in Banisteria

One of the original intentions in the design of *Banisteria* was to add an historical dimension to our knowledge of natural history on Virginia. We have accomplished that with the publication of several historical articles in previous numbers. However, one aspect of our history not well explored and, indeed, one found almost entirely only in obituaries, is biographies of persons who paved the way for us. Thus, in this issue of *Banisteria* we begin the publication of a new section entitled "Natural History Biographies." This section will include biographical sketches, vignettes, personal recollections, and full-length papers. Such articles may include black and white photographs, descriptions of his or her contributions to the natural history of Virginia, unpublished information or observations, and bibliographies (annotated or not).

There is no minimum or maximum length requirement (although we do not want a book), but the article should improve our understanding of the contributions made by that person. All manuscripts for

this section should be submitted to the co-editor, Joseph C. Mitchell, Department of Biology, University of Richmond, Richmond, VA 23173; queries: phone/FAX 804-740- 7086, email jmitchel@Richmond.edu.

4. Trichoptera of Virginia project

A long range survey of the caddisflies of Virginia has been initiated as a joint effort of the Virginia Museum of Natural History and the Division of Biological Resources, U.S.G.S. The principal investigator, Dr. Charles R. Parker (DBR, Great Smoky Mountains National Park, Gatlinburg, TN), is a leading authority on Nearctic Trichoptera, and assembled a notable collection of these insects at VPI&SU while he was enrolled there as a doctoral candidate. Collaborator Richard Hoffman has accumulated material at VMNH for the past decade and will accelerate field activities during the next. He and Dr. Parker have already published two accounts relating to Virginian species in previous issues of *Banisteria*.

It is anticipated that the results of this survey will appear as three numbers of "The Insects of Virginia," each devoted to one of the three local suborders of Trichoptera, in a standard format with consecutive pagination. Species accounts will cover both adult and immature stages, with descriptions, illustrations, and distributional maps.

Covering a large percentage of the caddisfly fauna of eastern North America, the completed treatment will effectively replace the now outdated "Caddisflies, or Trichoptera, of Illinois" (Ross, 1944, Bull. Illinois Nat. Hist. Surv. 23: 1-326) as the baseline reference for this region.

Members of VNHS are invited to participate in this effort by contributing preserved material of both adults and immature stages. Specimens from anywhere in the Commonwealth will be welcomed, but the Coastal Plain is the part of Virginia most in need of sampling. Contact Richard Hoffman at the Museum for further information. (Phone 540-666-8629; FAX 632-6487, e-mail rhoffman@vmnh.org).

Muscipula Regia, s.
Lychnis viscosa flore
amplo coccineo.